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STUDIES IN THE PSYCHOLOGY OF THE THEATER

ROBERT T. ROSS

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STUDIES IN THE PSYCHOLOGY OF THE THEATER

I. Preliminary Studies of Audience Reactions to Color[1]*

ROBERT T. ROSS
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Art is a kind of record of the personality of the artist. The artistic creation, whether it be music, painting, poetry, or drama, reflects something of the feelings and character of the artist. But an artistic work without an audience is stillborn, for presumably the artist records his impressions for the purpose of calling forth in others those subtleties of feeling which he himself has experienced; of recreating, as it were, his own mood in his audience. This definition of art is arbitrary, but for our purposes it is sufficient.

Some of the arts reach the audience directly, others require interpretation. Paintings, statuary, architectural creations, and literary works intended to be read require no intermediary between artist and audience except the works themselves. Music, dramatic literature, and the dance, however, in the absence of their creator, demand the services of interpretative artists whose function it is to perform from the artistic work in such a manner as to transmit the artistic intent of the artist to the audience. The director, therefore, whether for music, drama, or the ballet, must translate into sound or sight the artistic record which consists of notes, words, or choreographic design. It is necessary, therefore, that the director be aware of the intent of the artist and attempt to make this intent clear to the audience.

There is another difference between what we may call the "direct" or "individual" arts and the "interpreted" or "cooperative" arts which is fully as meaningful as the need of an

* Recommended for publication by Dr. J. R. Kantor, March 9, 1938.

[1] This study was made possible by grants-in-aid from the Council of Research in the Social Sciences at Stanford University, the National Research Council, and Mr. Robert Taylor of Metro-Goldwyn-Mayer Studios. The author is deeply indebted to Mr. Charles E. Fitts, Research Assistant in the Psychology of the Theater at Stanford University, for his generous help in preparing the manuscript.

interpreter; this is the transient nature of the "performed" arts. One may return again and again to view a picture or a building, but a play once performed or a musical selection once played is no more (neglecting performances embalmed on record or film). Whatever artistic impression the audience receives must be contemporaneous with the performance or in faulty retrospect.

This transient quality of a performance means that the problem of interpretation becomes extremely complex, especially in drama where the artistic effects are created as well by sight as by sound. Vision and audition in ever-changing relationships are the media of dramatic art. It is through these kinetic media, in relatively brief times, that the director must attempt to convey the intent of the playwright.

In general, the most stable part of a dramatic scene is the setting and design, then the costumes, the lighting, the movement and, finally, the lines. Presumably the characters furnish the basic stability in visually joining scene to scene as recognizably the same entities. The coherence and unity of the plot cement the entire production.

It is of interest that stage design, costumes, lighting, movement, and the visual recognition of characters all belong to the modality of sight, while only the auditory recognition of characters and the lines themselves belong to the modality of sound. Although the play is recorded in words which may be read, it is primarily a creation to be "seen" as well as "heard."

This brings us at once to a consideration of the part of "seeing" in dramatic art. Drama has not always been as much a visual art as it is in the contemporary theater. The early Greek theater with fixed set, buskin, and mask was far more constrained in its creation of visual impressions than the realism of Belasco or the impressionism of Appia. The modern theater with towering loft, mammoth scene-dock, crowded property room, extensive costume department, elaborate make-up facilities, and complex switchboard attests to the modern importance of visual impression.

But we may well ask of what value visual impressions are in dramatic art. The Greeks and Chinese developed a drama with little visual complement. If the design and movement of stage and character contribute nothing to the essential artistic effect of the production, surely they are but expensive adjuncts to the art. On the other hand, if the visual stimuli of the dramatic performance serve to heighten the

artistic effect for which playwright and producer are striving, then in the interests of economy, and especially in view of the short duration of the scene, they should be used to their full potentiality.

The present enquiry is concerned with this problem of the efficacy of visual stimuli as presented on the stage in producing in the audience the effect intended by the director. No one will readily deny that some effect exists, but its nature and strength occasion argument. Designers, lighting technicians, costumers, and make-up experts all attribute to their particular field the major portion of whatever effect the audience experiences. It is our purpose here to refer to the audience itself in an attempt to evaluate the importance of the visual impressions met with in the theater.

Amongst the factors contributing to visual impression, color plays one of the most important roles. No scene can be played without its complement of color, even if it be limited to black and white. But there is a paucity of data regarding the effects of colors on theater audiences. The experimental literature is not barren of studies of color preference, color dominance, and studies of the various visual phenomena usually considered under perception; but there is good reason to suppose that under the specific set occasioned by local theatrical traditions, results from other fields of investigation may prove of little value.

There are in the theater traditions which act as guides for the use of color. It is sometimes maintained that warm colors (yellow to red) are more suitable for comedy and cool colors (green to violet) for tragedy. Some designers feel that harmony of value is the important feature and that hue makes little or no difference, while still others insist that the form and line of the setting create a mood which color and light are powerless to influence. And some producers list for each color the effects it may be expected to produce and the scenes for which it is suited. But a perusal of the genesis of these rules and traditions leads one to discover that they are matters of artistic intuition rather than of objective observation.

It is not here intended to reduce all art to a set of algebraic equations, to give immutable laws regarding the use of color or the reactions to be expected from the audience. It will be many centuries, if ever, before aesthetic experience may be objectively described and predicted. But it has seemed of interest both as a problem of aesthetics and of psychology to discover how audiences react to different col-

ors when seen in the theater, to attempt to discover the genesis of these reactions and their stability, and to arrive at some evaluation of the validity of the artistic intuitions which at present guide the scenic designer.

The studies reported in this preliminary paper are in no wise to be taken as a complete analysis of color reactions; they are merely explorations of an objective and psychological nature into the problem of the consistency and variability of audience reactions to highly artificial theatrical conditions. They indicate, it is hoped, the fertility of the field for further investigation and serve to call attention to some of the general characteristics of audience reactions to color.

COLOR: HUE, BRIGHTNESS AND SATURATION

In dealing with the effects of color, as is the sole concern of these preliminary studies, it is necessary to differentiate between three aspects of a colored stimulus. The first of these is "hue" which has "wave-length" as its physical correlate. Typical hues are red, orange, yellow, green, blue, violet, and their intermediate hues, all of which may be found in the solar spectrum, and the purples which blend into red at one extreme and into violet at the other. The purples are not found in the spectrum.

The second characteristic of a color is its "brightness" which corresponds to its physical "intensity," or amount of radiant energy. Thus if a 60-watt bulb and a 100-watt bulb were both dipped in red dye and then lighted they would both have the same hue (red), but the color of the 100-watt lamp would be the brighter. Unfortunately there is a disparity between physical intensity and apparent brightness, for in an equal-energy spectrum (that is, a spectrum which radiates the same amount of luminous energy at each wavelength) the yellow-green appears brighter than the other portions, the apparent brightness decreasing at first rapidly and then slowly as the red and violet ends of the spectrum are approached. This phenomenon means that if two colors of different hue be matched for brightness (e.g., a yellow and a violet are made to appear of the same brightness by changing their relative intensities) it will be found that their physical intensities are quite different.

The third characteristic of a color is its "saturation" which corresponds to its physical "purity." The saturation is always measured in terms of percentage of white light of the same intensity which is mixed with the hue. If there

is no white light mixed in, the color is said to be 100% or fully saturated. If the color is completely desaturated (0% saturated), it is pure white light of intensity equal to that of the hue. Suppose, for example, that five spotlights are all focused on the same area of a white flat and an illuminometer target mounted in the middle of the area. Now suppose a red gel is placed in front of one spot alone, the others being white, and the bank of spots turned on. We will obtain an illuminated area which will appear pink. Suppose the illuminometer reads 1,000 foot-candles. We will roughly specify our color as follows: hue, red; brightness, high; saturation, low (approximately 20%). If we now place red gels in front of four spots and dim up the whole bank to 1,000 foot-candles, we will roughly specify the color as: hue, red; brightness, high; saturation, high (approximately 80%). The exact specification of these three variables is difficult but not impossible. A further difficulty is introduced, however, by the fact that as brightness increases, other things being constant, a color apparently desaturates. Methods have been evolved, however, for specifying colors in such a way as to give measures of their hue, brightness, and saturation. The analysis does not apply to pigment colors but to light mixtures such as are met with when using gels.[1]

SETS A, B, AND C

The three studies reported in detail in this paper are the fourth, fifth, and sixth (Sets *D*, *E*, and *F*) of the entire series. The first three studies served merely to indicate pitfalls and method. It may not be amiss, however, briefly to describe them. Sets *A*, *B*, and *C* were obtained with the cooperation of Professor Stanley R. McCandless and Mr. Walter Aldrich of the Yale Drama School.

Set *A* was obtained from 28 students in an advanced course in stage lighting at the Yale Drama School. The colors to which they reacted were thrown against the reverse side of a ground glass screen and gave a rectangular field 12x18 inches. All of the colors were produced by placing Brigham Gelatines in front of a baby spot and projecting on the screen. All colors were adjusted to an illumination-value at the glass of 9 foot-candles by means of a Weston Illumination-meter provided with a Viscor filter.

[1] In these studies no attempt was made to control the three variables independently. The intensity of the clear beam of the projector was adjusted to a fixed value and gel slides put in front of it. Later an analysis of the responses in relation to the hues, brightness, and saturations of the various gels was made.

The audience was provided with blanks on which they were asked to name the hue, saturation, and intensity of the color, to describe the situation to which it was best suited on the stage and to state whether the situation was indoors or oudoors. The following lists of responses are typical:

Medium lavender (Gel #18): romantic, royal, cool morning, love scene, spring comedy, death, Japanese tea screen, boudoir scene, ordinary night scene, fireplace, sunrise, twilight, dusk, passionate, quiet—little action, walk in the woods, circus, ballroom, quaint romantic old castle, sand —torrid desert, drawing-room, drawing-room, far-away land, intimate comedy, and three subjects gave no response.
Moonlight blue (Gel #41): water, river shore, living-room, palatial, night scene, summer, plotting, Midsummer Night's Dream, dismal murder scene, sky, winter moonlight, mystery, tragedy, outdoor moderate action, ghoulish, moonlight on snow, murder, moonlight love scene, dream scene, crisp smartness, summer sky—children at play, vivid strong action, comedy fun, summer day, and four gave no response.

It is obvious that no satisfactory classification can be made of this jumble of impressions. In spite of instructions to the contrary, the subjects are recording images of things rather than the feeling-tone which accompanies the image and in which we are primarily interested. It was thought of interest to discover how many responses one color might call forth in any one individual. To this end two students who had shown exceptional ability in description of colors were presented with the series and asked to talk freely about what the color meant to them. Following are their responses on the same two colors reported above:

Medium lavender (Gel #18) Subject K: "old ladies, twilight, rainy, Camille, the fog in Anna Christy, pastoral dance, not much action, words but not movement, gauzy, see beyond, sentimental, weepy but not in a subjective way. If indoors, a low-lit room, the outdoors effects are in the room. If outdoors, just before dawn or twilight. Cold on the surface, warm underneath. A contradictory color."

Subject L: "like it, pageant, fairly romantic, possibly cold and unnatural, air of eery, before sunset, not used but acceptable as natural, action could be intense, not for slow-moving tragedy, quite some life, red for excitement."

Moonlight blue (Gel #41) Subject K: "wonderful, blue is my favorite color, Russian, Mediterranean, sentimental moonlight, not real but twice as much fun, romantic, all out of doors, movement is slow and intense, water, satin, any-

thing from complete reality to utter stylization, woods, a color to wrap around you, very gay, not the least bit sad, saccharine, being sung to sleep, Christmas, ten-cent postcards, too dark for snow at night, very metallic quality."

Subject L: "very cold, ghostly, intense tragedy, moonlight, sky, late evening, fast action, premonitions, shadowy things pass around the stage, connotations of night, sky before dawn, end of night, classical, tragic."

Here, again, the individual differences are sufficient to preclude any satisfactory classification of the responses. One has the feeling that there is a certain underlying sameness about the responses to any one color, but it is impossible to find this common denominator without indulging in as much intuitional guesswork as we are trying to escape. This first experiment indicates quite clearly, however, that colors call forth some response in individuals, even when the color seen is that of a plain and barren surface.

Set *B* was the same as Set *A* except that it was given to 77 sophomores in a psychology class in Yale College. The responses of this group to the colors reported for Set *A* are given below:

Medium lavender (Gel #18): no response (4), a scene with flowers, dawn (2), dance scene (2), love scene (3), sunset—clouds—morning, at sunset (8), early morning meeting, sunset on the hills, two people loving, start of sunset, conversation in a garden, fire in forest (2), man arising from bed, exotic boudoir—passion (any type), boudoir (4), sunset garden, forest at sundown, peasant maid, men talking over battle, someone roasting in a corner of hell, a meal between two lovers, morning on an island, bedroom scene (6), social conversation, people sitting at dinner—at twilight—peaceful conversation, ballroom, a woman's bedroom, a child's blanket, fire, child's bedroom, harvest, peaceful twilight, murder on stage, boudoir love, dressing room, hallway, exciting, morning, late afternoon, home life in 1870's, gardens (2), parlor, boating, summer sunset, at dawn in woods, sunrise, mountains in winter sun, boudoir—bedroom, low talking, etc., bedroom scene, man and wife, scene of battle, ocean at sunset, festive.

Moonlight blue (Gel #41): no response (9), forest, boat race, outdoors—foliage in spring, moonlight love, night time—someone sneaking through the forest, Bermuda water (2), clear summer evening, violence, night—few people—little action, murder set, a night in Venice, under water, storm on the sea, street scenes at night, fields of grass, party, sea—ocean, scene in well lighted room, villainy, romantic scene,

water—seashore, ocean scene, water—swimming, water scene, water, sky, ghost scene (mysterious but not horrible), ghastly, sky scene, love under the stars, love scene (2), night, boats on river, bright daylight, playing pool, under sea scene, twilight, water in a pool—outdoor, probably tropical or Mediterranean, light (bright) passing through a reading shade, living room in college, ship on horizon, great outdoors, ocean—water—boats, in a submarine—fear of sea, ship sailing on sunny sea, a luxurious party, swimming party at Jones' Beach at night, tropical sea scope, Indian (Asia) Dance, jealousy—a superficial type of woman in scene, murder at night, early morning conversation, seashore—fishing, thoughtful reverie, people in the moonlight, deep foliage of forest, chorus dancing, acetylene torch at night, night time (anything), time after sunset—stars beginning to appear, under water—fish or fishing, alley scene, wild life—birds, etc., an eerie—tense scene, (unreadable) in forest, night.

An extended analysis of the responses obtained for the various colors indicated clearly that it was impossible to bring any consistent order out of the multiplicity of responses.[1] It may be seen that there is some general basic element in the responses, but the very words used are so many and the use of images so prolific that analysis becomes impossible. To obviate this difficulty in part without forcing responses into given categories, another method was attempted.

In Set *C*, twelve members of a class in experimental psychology were seated in a dark room and asked to respond with mood names only to the stimuli presented. Five photographs of sets which had been constructed for regular productions at the Yale Theater were used. These photographs were of the sets alone without characters. Five colored gelatines were picked (red, yellow, green, blue, and purple), and each of the five pictures was shown under a different color. At a following session, two days later, the same five pictures were shown, this time each one under a different one of the five colors. This procedure was continued until each photograph had been seen under each of the five colors. Then the five colors were shown alone, as were the five photographs.

The following lists of responses indicate the nature of the results. The photograph was of a set used in *Venice Preserved* in the Yale Theater. The set consisted of a long

[1] The author is indebted to Mr. Peter Delaney of Yale University and Mr. Robert Presnell, Jr. of Stanford University who struggled with this analysis.

flight of classic stairs surmounted upstage center by a dais. The responses in parentheses are second choices.

Set alone (White light)	Blue gel alone	Set seen with blue gel
majestic	despondency	gloomy (mysterious)
majestic (mystical)	romance (beauty, unreal)	solitary (cold)
pathos (despair, sad)	gloom (mystery)	gloomy (mystery)
mystery (intrigue, lonesome)	relaxation (calm, quiet, rest)	
	pleasant	gloom (dark, dingy)
unpleasant	passionate (content, serene)	cool (easy, pleasant)
sad (tragic, high tension)	happy	peaceful (quiet, restful)
formal (calm, restful)	awe (worship, affection)	fear (dread)
stately (simple, beautiful)	romantic (warm)	romantic (dignified)
grand (beauty)	quick (serene, peaceful)	deathly (secret)
impressively sad (beautiful)	romantic (exciting)	romantic (erotic)

Again with these responses, variability is so great that generalizations are impossible without subjectively reading into the data meanings which were perhaps not intended. To generalize from responses of romantic, deathly, fearful, and peaceful is difficult, yet the general impression from the third column, of gloom, quiet, and depression is inescapable. There seems to be some basic quality of the scene to which most of the group react.

THE RATING SCALES

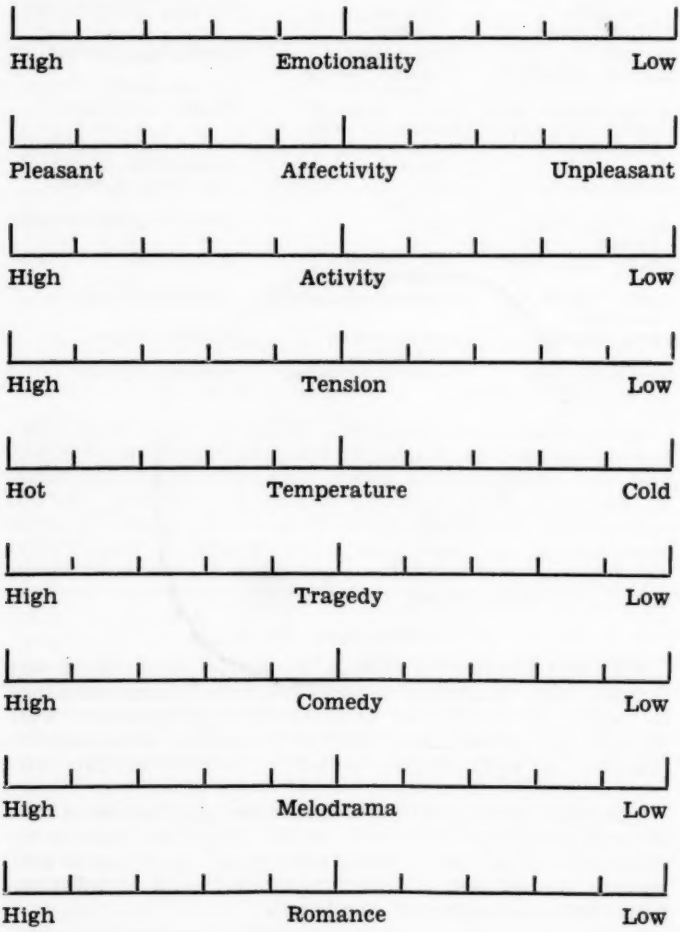
With the findings of Sets *A*, *B*, and *C* in mind, it was thought wise to attempt a measurement of group reactions to colors, in which the possibilities of description were limited, but the amount of each mood-quality listed could be indicated by each subject. Sets *D*, *E*, and *F* used this controlled response technique.

The scales used in rating the audience responses were constructed with two criteria in mind: first, the type of response which was indicated as basic in Sets *A*, *B*, and *C* and, second, the opinion of directors of drama as to what information was important for them[1].

The scales decided upon were nine in number and comprised the following group:

[1] The writer is indebted to Mr. Gilmor Brown and the Associate Directors of the Pasadena Playhouse for their especial cooperation.

Color Number _____



Comment: _____

Figure 1
Scales used by the audience in recording their reactions to colors.

1. Emotionality: the degree of emotionality which a scene lighted with the color under consideration might be expected to possess.
2. Affectivity: the degree of pleasantness (or unpleasantness) associated with a scene lighted with the color under consideration.
3. Activity: the amount of movement which might be expected in the scene.
4. Tension: the degree of tension or relaxation in the scene.
5. Temperature: the degree of heat or cold associated with the color.
6. Tragedy: the degree of tragedy associated with the scene.
7. Comedy: the degree of comedy associated with the scene.
8. Melodrama: the degree of melodrama associated with the scene.
9. Romance: the degree of romance associated with the scene.

Each scale, as is shown in figure 1, was divided into ten equal divisions with the neutral or moderate situation at the center. The high end of the scale was at the left and the low end at the right. In reading off scores, therefore, the numerical scale was read from right to left; zero at the right-hand end and one hundred at the left. Each division on the scale measured 10 units. An "emotionality" rating of 10 meant that the subject considered the color ill-suited for an emotional scene or, better, that the amount of "emotionality" to be expressed in a scene so lighted was little. A rating of 50 meant that the subject expected a moderate amount of "emotionality" to be expressed in the scene, and a rating of 95 indicated that he expected a highly emotional scene. In calculating medians and coefficients of correlation the data were grouped into ten class-intervals corresponding to the ten divisions on the scales: 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89, 90-100. For purposes of graphical representation, the scores were combined into five class-intervals, 0-19, 20-39, 40-59, 60-79, 80-100, and expressed as percentages of the total number of subjects using the particular scale. These percentages are given in the appropriate tables and graphs.

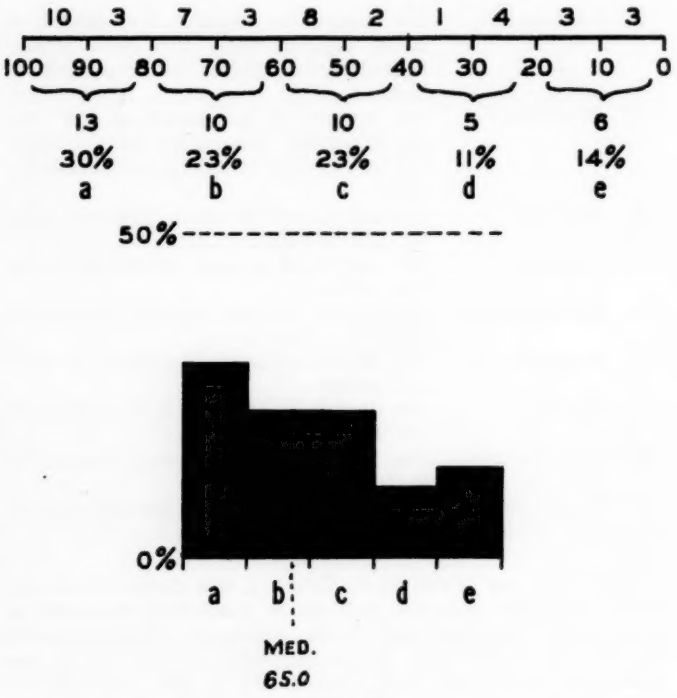


Figure 2

The construction of the bar-diagrams.
(see text for explanation)

The bar-diagrams are possibly the most important data of this study, and it is well thoroughly to understand their meaning. Reference to figure 2 may serve to make this meaning clear. (The example is from the "activity" scale of Gel #2, Set *E*.) In this case the color "Light Flesh Pink" was thrown on the screen and the subjects asked to rate, amongst other things, its "activity." The scale which they used for this rating was 10 cm. long and divided into 10 equal divisions. This scale is represented in the figure by the straight line. The scales used by the subjects did not have the scores represented on them. Each of the 44 subjects put a check-mark on this scale at the place which

seemed appropriate to him. High "activity" called for a check-mark on the left-hand end of the scale, low "activity" for a mark on the right-hand end. After the ratings had been made, the number of check-marks in each division was counted; these frequencies are shown above the scale in the figure. From these data, the medians were calculated.[1]

After the calculation of the medians, the scores were combined, as shown, into five groups instead of ten (the frequencies of the combined groups are below the brackets in the figure) and these combined frequencies expressed as percentages. These percentages were then plotted as bar-diagrams. The bar-diagram shows for this case that 30% of the scores fell between 80 and 100, that is, that about one-third of the group considered "Light Flesh Pink" to be a very "active" color, one-fifth (23%) thought it to be fairly "active," one-fifth (23%) thought it to be moderately "active," one-tenth (11%) considered it as fairly "inactive" and one-tenth (14%) considered it as very "inactive." The diagram indicates this spread of opinion with the tendency toward high activity, and when the position of the median (65.0) is taken into account, a fairly accurate picture of the distribution can be obtained. The bars marked *a*, *b*, *c*, *d*, and *e*, may be thought of as corresponding respectively to the ratings very high, high, moderate, low and very low.

If the ratings were purely chance, the bar-diagram would theoretically have 20% of the responses in each of the five categories. If as many as 45% of the responses fall in a given category, the rating is to be taken as statistically significant.

SET D: REACTIONS TO COLOR NAMES

This preliminary study was given with two purposes in mind: (1) to discover whether there was any consistency of response to be expected by the use of the scales, and (2) if consistent results were obtained, to inquire further into the possible part played by verbalization in making responses to color.

The test was given to a group of 23 students, 9 men and

[1] The median is the score of the middle case, or the score which is exceeded by half the group, and below which the other half are to be found. In this case, the median is at 65. Twenty-two out of the 44 rated the "activity" as less than 65, and 22 rated it as more. The fact that the median is at 65 indicates that the tendency of the group is to consider "Light Flesh Pink" more "active" than "inactive," but not as "active" as would be the case had the median been, say, 85.

14 women, in an advanced acting class in Stanford University. All of the members of the group had seen at least one play in the year past with an average of 9 plays seen; they had all acted in at least one play and in an average of five; they had all had at least one course in drama with an average of four courses. Forty-three percent of the group had participated in at least one project in technical theater work with an average amongst the 43% of two such produc-

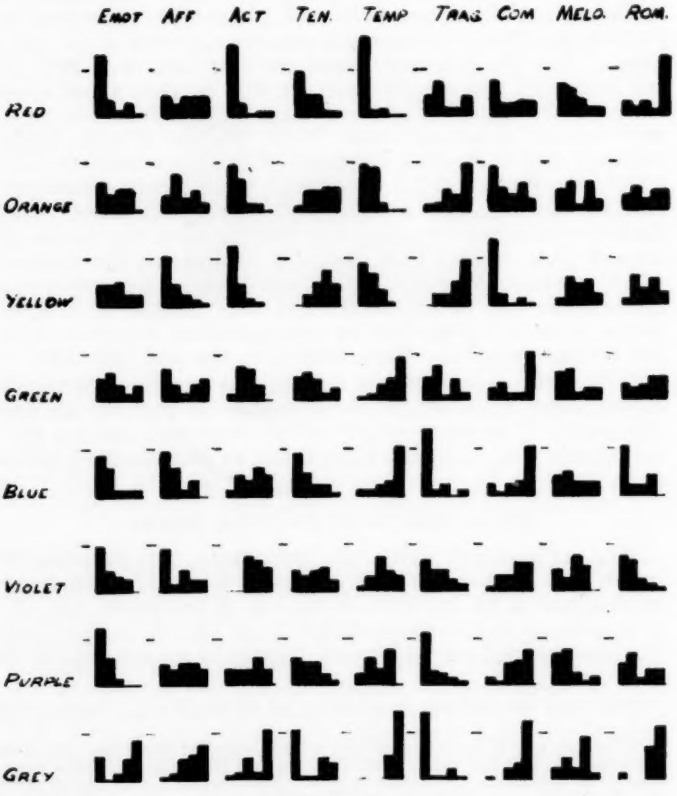


Figure 3

The distributions of the audience responses on the various scales. Set *D*.

TABLE I

MEDIAN VALUES FOR THE DIFFERENT SCALES FOR ALL COLORS

SET D

	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Red	90.0	50.0	91.5	80.0	95.7	66.0	73.3	70.0	12.2
Orange	60.0	64.0	80.0	40.0	80.0	22.5	80.0	62.5	55.0
Yellow	58.0	82.0	88.7	30.0	76.6	21.7	91.5	53.3	52.5
Green	66.6	63.3	60.0	66.6	25.0	68.0	20.0	72.0	40.0
Blue	77.5	80.0	40.0	78.3	20.0	91.5	20.0	60.0	83.3
Violet	80.0	65.0	36.0	53.3	50.0	72.5	33.3	55.0	73.3
Purple	87.5	53.3	45.0	64.0	56.6	85.0	32.5	75.0	64.0
Grey	31.6	30.0	19.3	85.0	14.4	88.5	9.2	40.0	18.0

TABLE II

PERCENTAGES OF RESPONSES
FOR VARIOUS DEGREES OF JUDGMENT

SET D

	Emotionality					Affectivity					Activity				
Red	65	17	4	13	0	22	13	22	22	22	78	13	0	4	4
Orange	30	17	26	26	0	17	39	13	22	9	48	35	9	9	0
Yellow	22	22	26	13	13	52	22	13	9	4	64	23	9	5	0
Green	26	30	17	9	17	35	17	9	17	22	9	39	35	17	0
Blue	44	30	9	9	9	48	30	4	17	0	9	22	17	30	22
Violet	48	22	17	13	0	44	9	22	13	13	0	0	39	35	26
Purple	61	30	9	0	0	22	17	22	22	17	17	17	17	30	17
Grey	27	0	9	23	41	4	9	22	26	39	5	9	23	9	55
	Tension					Temperature					Tragedy				
Red	48	22	22	4	4	87	4	9	0	0	22	39	9	9	22
Orange	4	22	22	26	26	48	44	9	0	0	4	9	22	17	48
Yellow	0	13	26	39	22	44	35	17	4	0	0	13	13	26	48
Green	26	30	22	9	13	4	9	17	22	48	26	39	4	22	9
Blue	44	26	13	13	4	9	9	13	17	52	70	9	13	0	9
Violet	22	17	22	26	13	4	17	39	22	17	35	22	22	13	9
Purple	30	26	26	13	4	13	30	17	39	0	57	17	13	9	4
Grey	52	4	4	22	17	0	0	0	26	74	74	4	4	13	4
	Comedy					Melodrama					Romance				
Red	39	13	13	17	17	35	30	17	9	9	13	9	13	4	61
Orange	48	26	17	4	4	22	30	4	30	13	17	26	13	22	22
Yellow	70	13	4	9	4	9	30	22	26	13	9	32	18	27	14
Green	13	17	9	9	52	30	35	9	13	13	17	13	17	26	26
Blue	13	4	13	17	52	22	26	17	17	17	52	13	13	22	0
Violet	4	17	17	30	30	22	13	39	26	0	39	35	13	9	4
Purple	9	4	22	26	39	35	39	13	4	9	22	35	9	17	17
Grey	4	0	13	17	65	13	22	13	44	9	9	0	0	35	57

tions; 90% of the group had attended at least one concert during the year with an average amongst the 90% of six concerts. The data indicate that the group is actively interested in the problems and techniques of the theater.

Each member of the group received a set of instructions such as are shown in Appendix *A*, and eight rating scales

TABLE III

INTER-CORRELATIONS
MEANS OF ALL COLORS

SET D

	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Emot.	—	—0.25	0.18	0.58	0.45	0.37	—0.13	0.86	0.47
Affect.	—	—	0.30	—0.37	0.02	—0.29	0.57	—0.17	0.51
Activity	—	—	—	0.02	0.87	—0.66	0.84	—0.05	—0.26
Tension	—	—	—	—	—0.07	0.64	—0.30	0.82	0.29
Temp.	—	—	—	—	—	—0.62	0.76	0.02	—0.09
Tragedy	—	—	—	—	—	—	—0.87	0.67	0.35
Comedy	—	—	—	—	—	—	—	—0.43	—0.04
Melodr.	—	—	—	—	—	—	—	—	0.42
Rom.	—	—	—	—	—	—	—	—	—

TABLE IV

MEDIAN COEFFICIENTS OF CORRELATION OF
INDIVIDUAL JUDGMENTS

SET D

	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Emot.	—	0.15	0.20	0.28	0.23	0.18	0.07	0.14	0.11
Affect.	—	—	0.26	—0.14	0.42	—0.34	0.46	—0.20	0.66
Activity	—	—	—	0.00	0.43	—0.09	0.39	0.15	0.09
Tension	—	—	—	—	—0.11	0.42	—0.18	0.21	—0.31
Temp.	—	—	—	—	—	—0.15	0.22	0.05	0.31
Tragedy	—	—	—	—	—	—	—0.47	0.21	0.17
Comedy	—	—	—	—	—	—	—	—0.02	0.36
Melodr.	—	—	—	—	—	—	—	—	—0.08
Rom.	—	—	—	—	—	—	—	—	—

like those in figure 1. Each rating blank had at the top of it the name of one of the colors; *red, orange, yellow, green, blue, violet, purple,* and *grey.* Each color was rated on all nine scales. The ratings were on the basis of the names alone; no colors were seen.

The results were treated by the methods already discussed and are given in Tables I and II and in figure 3. Table I shows the medians for every scale for each color. A comparison of the medians indicates the tendency of the results. For example, red is the hottest color with orange, yellow, purple, violet, green, blue and grey following in that order, and grey considered as definitely cold.[1] The percentage of responses in each of the five categories is given in Table II and shown graphically in figure 3. Reference to these data will indicate the precision of the medians. For example, there is much more agreement regarding the "ac-

[1] It is of interest to note that if the percentage of red required to match these colors in a tri-chromatic mixture is calculated and the colors arranged in rank order according to this percentage, the same order of colors is obtained as from the temperature ratings.

tivity" of yellow (88.7) than there is regarding the "tension" of grey (85.0) although the median values are approximately the same.

A further inspection of the data brings to light some interesting correlations. It may be seen, for example, that high values for "tragedy" are accompanied by low values for "temperature"; that high values for "tragedy" are associated with low values for "comedy"; and that high values of "temperature" and "comedy" tend to occur together. In statistical terms we say that we have a high positive correlation (approaching 1) between "comedy" and "temperature" and a high negative correlation (approaching minus 1) between "comedy" and "tragedy" and between "tragedy" and "temperature." (The values of these coefficients may be seen in Table III.) In other words, the traditional "warm colors for comedy and cool colors for tragedy" seems to be confirmed in the judgments of these characteristics by the audience. On the other hand, there seems to be little discernible relationship between ratings of "activity" and "tension." Knowing one, it is impossible even to predict the probable rating for the other. This is referred to statistically as low correlation (approaching zero) and indicates a lack of relationship between the two characteristics.

In Table IV the coefficients of correlation[1] for the judgments of the same subject for different scales are given. If we calculate the relationship between "emotionality" and "affectivity" for individual scores, we proceed as follows: First we take "red" and discover how the first subject rated it for "emotionality" and also how he rated it for "affectivity"; we enter these two ratings on a chart and then record the ratings for subjects two, three, four and so on to twenty-three. Then we calculate a coefficient of correlation for "emotionality" vs. "affectivity" for red. This value is 0.07. The coefficient is then calculated for "orange" and turns out to be 0.56; 0.12, for yellow; 0.29, for green, etc. We then arrange the eight coefficients in rank order and choose the middle one (median) as representative. Table IV gives the median coefficient of correlation for each relationship. It will be seen that far less predictive value can be had from individual ratings than from group ratings since the former cluster about zero much more than do the latter (compare with Table III).

[1] The coefficient of correlation varies from plus one to minus one. Plus one is the "high" positive correlation, as explained above. Correlations of 0.40 or above are probably significant.

The relationships between "temperature," "tragedy" and "comedy" are indicative of the type of consistency which we seek and give evidence of the utility of the scales. In general, we may say that the scales give results consistent with normal expectations where such expectations exist (as in the case of the negative correlation between "comedy" and "tragedy"), that these relationships are meaningful in the case of median judgment for each scale, but that individual differences are so great that the prediction of individual responses is apparently impractical.

SET E: RESPONSES OF AN UNTRAINED AUDIENCE

Since the results of Set *D* indicated that some consistency of response might be expected from the use of the scales, the next step was to present actual colors to a large group of relatively unsophisticated subjects and to examine the type of response given.

A group of 44 students, 11 men and 33 women, in an undergraduate class in experimental psychology was chosen for experimentation. This group was trained in making and recording judgments, but they had been given no specific work with color. Only 85% of this group had seen at least one play during the year (average of 3.5 plays[1]), 5% had acted in at least one play (average of 1.0), 11% had done technical work in at least one production (average of 5), 32% had had at least one course in dramatics (average of 2), and 78% had attended at least one concert (average of 9). It will be seen by comparison with group *D* that this audience is relatively unsophisticated in the practical problems of dramatic production.

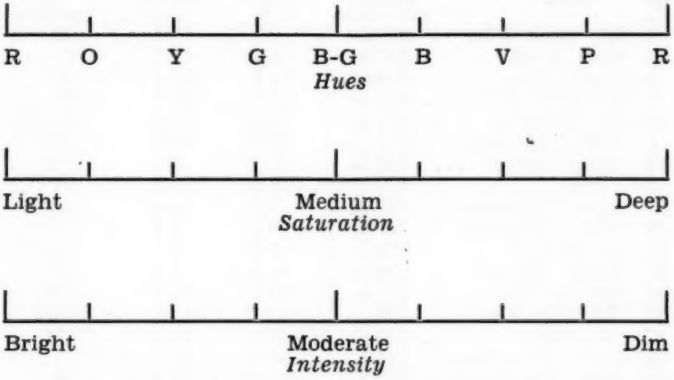
The test blanks furnished to this group were somewhat different, but essentially the same as those used with Set *D*. The pages of directions are reproduced in Appendix *B*; the scales were the same as those shown in figure 1, with the addition of the "hue," "saturation" and "intensity" scales shown in figure 4, and the check-list of descriptive adjectives which was taken from Hevner-Müller's work.[2]

The subjects were seated in a dark room and provided with test blanks, pencils and flash-lights. The colors were projected upon a screen by means of a standard stereop-

[1] The averages given refer to those who had seen at least one play. Thus if three subjects had seen 0, 2 and 6 plays respectively, we would say that 66.6% had seen at least one play, with an average of 4 (not 3.3) plays seen.

[2] Hevner-Müller, Kate, "Experimental Studies of the Elements of Expression in Music," *Amer. J. Psychol.*, 1936, *68*, 246-268.

Color Number ————



Check all the terms in the following lists which seem appropriate to the color. Check as many or as few as you like.

.....bright	.....calm	.....dramatic
.....vivacious	.....serene	.....forceful
.....sprightly	.....soothing	.....vigorous
.....cheerful	.....tender	.....martial
.....happy	.....sentimental	.....ponderous
.....gay	.....longing	.....emphatic
.....joyous	.....romantic	.....majestic
.....carefree	.....plaintive	.....exalting
.....sparkling	.....sad	.....soaring
.....playful	.....pathetic	.....triumphant
.....merry	.....mournful	.....elated
.....jovial	.....melancholy	.....exciting
.....humorous	.....depressing	.....imperious
.....whimsical	.....gloomy	.....restless
.....fanciful	.....heavy	.....stirring
.....quaint	.....tragic	.....spirited
.....delicate	.....dignified	
.....light	.....spiritual	
.....graceful	.....solemn	
.....lyrical	.....sober	
.....poetic	.....serious	
.....leisurely	.....grave	
.....gentle	.....earnest	
.....dreamy	.....philosophical	

Figure 4

Scales used by the audience for the specification of hue, saturation and brightness, and the adjective check-lists.

TABLE V

CHARACTERISTICS OF THE COLORED GELATINES

Gel No.	Name	Dominant Wave-Length	Purity in %	Intensity in %	Color Designation
2	Lt. Flesh Pink ..	640.5	10.7	77.7	R
6	Rose Pink	640.5	51.4	38.7	R
8	Deep Pink	519.0c	31.8	50.1	P
9	Dubarry Pink ...	523.0c	33.8	46.7	P
10	Lt. Magenta	515.0c	55.6	37.2	RP
11	Med. Magenta ..	515.0c	62.2	20.3	RP
14	Rose Purple	569.5c	67.4	8.4	VP
16	Violet	472.0	43.8	11.6	B
17	Spec. Lavender ..	577.6c	21.0	34.9	VP
18	Med. Lavender ..	579.0c	38.4	17.6	VP
20	Lt. Purple	577.6c	56.6	7.7	VP
22	Royal Purple ...	576.5c	79.6	4.9	VP
25	Daylite Blue	489.8	29.2	36.3	BG
26	Lt. Sky Blue	485.2	19.7	34.8	BG
27	Lt. Blue	489.8	57.1	23.6	BG
29	Spec. Steel Blue .	484.1	38.8	22.7	B
32	Med. Blue Spec. .	482.5	73.6	12.8	B
36	Non-Fade Blue ..	472.0	88.0	2.7	B
41	Moonlite Blue ..	488.2	55.4	12.2	BG
44	Med. Blue-Green	515.0	57.8	20.9	BG
48	Med. Green	525.0	48.3	28.9	G
49	Dk. Green	525.0	65.0	9.2	G
54	Lt. Straw	586.0	35.1	87.7	YO
57	Lt. Amber	586.7	87.8	72.8	YO
58	Med. Amber	593.5	86.3	64.8	YO
60	Dk. Amber	598.0	90.6	46.9	O
61	Orange	602.0	99.0	31.9	RO
62	Lt. Scarlet	593.5	35.6	75.0	YO
67	Fire Red	612.0	85.7	12.9	RO
75	Grey	581.3	19.2	40.0	Y
W	White	——	0.0	100.0	W

ticon. The illuminated area was 160 cm. long and 130 cm. high. With no colored gel in front of the projector, the illumination at the screen was 6.5 foot-candles. No changes were made in this basic illumination, so that the illumination of the screen when gels were used was in all cases less than this amount. Colors were shown on the screen for 90 seconds; during this time all scales and check-lists had to be filled in. This was ample time for rapid judgment but gave no opportunity for going back. In no case were the color names given to the group; all slides were given merely by number.

TABLE VI

COLOR NAMES OF HUES OF VARIOUS WAVE-LENGTHS

Wave-Length	Hue	Name
400-430	V	Violet
430-470	BV	Blue-violet
470-485	B	Blue
485-515	BG	Blue-green
515-565	G	Green
565-575	YG	Yellow-green
575-585	Y	Yellow
585-595	YO	Yellow-orange
595-600	O	Orange
600-620	RO	Red-orange
620-700	R	Red
485c-515c	RP	Red-purple
515c-565c	P	Purple
565c-575c	VP	Violet-purple

Samples of the gel sheets used were sent to Dr. Sidney Newhall at The Johns Hopkins University for calibration by the tri-chromatic process described by Hardy.[1] The coefficients for the gels are given in Appendix *C*. Using the tri-chromatic coefficients and assuming the projector lamp to be essentially equivalent to I.C.I. standard illuminant *A* with no essential change by reflectance at the screen, it is possible to state the dominant wave-length (hue), purity (saturation) and relative intensity (brightness) of the colors. These data are given in Table V. The relative intensities were measured in the Stanford Laboratory with a photoelectric cell and Viscor filter.

The results for the hue, saturation and brightness scales proved of especial interest. Table VI gives the hues for various wave-lengths as adapted from Hardy.

Using these data it is possible to give a name to each of the gels used in the study by finding the corresponding wave-length from Table V and finding the corresponding name from Table VI. The results of such a procedure give the color names shown in column 3 of Table VII; in column 2 are the names given to the gels by the audience. For the most part the variation in hue judgment within the audience was very low so that the values given are typical

[1] Hardy, Arthur G., *"Handbook of Colorimetry,"* M.I.T. Press, 1936.

TABLE VII

COLOR NAMES GIVEN BY SUBJECTS

SET E

Gel No.	Name Chosen by Audience	Color Designation from Table V
2	R	R
6	PR	R
8	PR	P
9	PR	P
10	PR	RP
11	PR	RP
16	B	B
17	V	VP
18	V	VP
20	V	VP
22	VP	VP
25	BG-B	BG
27	BG	BG
29	BG-B	B
32	BG-B	B
36	B	B
41	BG	BG
44	G	BG
48	YG	G
49	G	G
54	Y	YO
57	YO	YO
58	YO	YO
60	O	O
61	RO	RO
75	Y	Y
W	Y	W

TABLE VIII

CORRELATIONS OF PHYSICAL CHARACTERISTICS OF DIFFERENT COLORS (PURITY AND INTENSITY) WITH JUDGMENTS OF SATURATION AND BRIGHTNESS

	Purity	Intensity	(—0.32)
Saturation	0.87	—0.53	
Brightness (0.61)	0.62	0.16	

Coefficients in the body of the Table are partials. The correlation of Saturation vs. Brightness is 0.61, of Purity vs. Intensity is —0.32.

TABLE IX

MEDIAN VALUES FOR THE DIFFERENT SCALES FOR ALL COLORS

SET E

Gel No.	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
2	18.12	51.15	65.00	29.50	53.00	17.66	69.00	29.50	26.88
6	64.64	63.93	72.92	60.00	80.00	30.00	60.00	62.27	48.33
8	50.00	59.60	64.23	45.00	65.59	33.75	60.00	49.00	60.00
9	46.43	53.46	63.75	46.88	69.00	25.00	56.88	57.00	55.00
10	77.22	54.16	78.13	67.00	88.50	33.58	59.00	67.50	47.50
11	81.50	60.00	83.58	75.76	90.00	62.50	50.00	77.50	37.50
16	69.00	62.69	42.50	65.00	26.54	74.50	27.50	66.50	69.29
17	34.38	44.38	29.45	28.77	24.10	60.00	34.10	60.00	48.13
18	63.53	53.00	60.00	37.50	24.09	57.00	13.18	68.75	70.00
20	78.13	50.00	39.38	61.67	37.22	76.43	23.57	75.50	62.78
22	60.95	40.00	39.29	66.00	60.00	78.33	22.73	78.12	36.00
25	38.13	60.00	53.50	38.13	31.25	45.00	39.50	49.30	60.00
27	75.42	79.37	53.89	62.50	33.18	69.39	29.19	63.75	73.75
29	24.50	45.63	30.00	35.00	20.00	65.00	29.00	50.00	58.75
32	74.64	75.84	49.50	63.54	32.04	69.17	35.00	66.44	78.32
36	91.40	72.50	33.33	83.57	22.86	84.40	11.56	85.00	77.00
41	67.50	73.58	44.16	61.50	32.92	67.50	29.00	70.00	72.50
44	59.50	77.50	54.50	56.43	33.75	53.57	45.00	55.00	66.43
48	60.00	74.37	48.56	60.00	26.54	55.63	35.00	57.50	58.34
49	66.88	60.00	57.00	72.00	42.50	62.24	30.00	70.00	52.24
54	35.00	55.00	73.75	36.66	55.41	22.78	75.00	28.34	28.75
57	50.00	64.29	81.00	50.91	63.57	25.00	80.00	35.00	36.00
58	55.00	60.00	78.34	47.00	73.12	18.21	76.11	47.50	37.15
60	60.00	60.00	69.50	62.50	79.00	28.75	69.16	62.50	35.00
61	90.00	63.00	92.04	93.04	94.03	48.34	60.00	78.75	27.00
75	52.50	55.36	66.00	38.34	39.16	29.16	53.54	30.00	36.00
W	22.14	53.75	80.00	51.25	52.69	23.12	67.50	32.50	25.00

responses. The agreement with objective measurement is sufficiently high to indicate that the group is able accurately to judge hues.

It was possible directly to compare judgments of saturation with the purities given by the tri-chromatic process. A rank difference coefficient of correlation for the 27 gels was found to be 0.87 which again indicates the ability of the group to judge saturation. The same correlation of relative brightness to intensity, however, gave a coefficient of correlation of 0.16. The inter-correlations are summarized in Table VIII.

It would appear from these data either that judgments of relative brightness are extremely difficult to make, or that the subjects were confusing saturation and brightness. The differential sensitivity of the eye to different spectral colors might play a part in this judgment but an investigation of this possibility failed to disclose any relationship between judged brightness and hue. The data provide no other means of explanation.

TABLE X

PERCENTAGES OF RESPONSES FOR VARIOUS DEGREES OF JUDGMENT

SET E

Gel No.	Emotionality					Affectivity					Activity					Tension				
2	0	11	20	14	54	16	7	39	23	16	30	23	23	11	14	7	9	27	20	36
6	14	50	20	14	2	20	41	20	16	2	30	52	11	7	0	14	36	16	25	9
8	5	27	32	20	16	20	18	36	16	9	14	48	20	9	9	5	27	23	30	16
9	7	23	30	23	18	16	14	43	20	7	27	32	18	20	2	9	18	34	20	18
10	43	30	9	9	9	14	27	20	30	9	45	34	14	7	0	36	20	14	23	7
11	52	32	2	11	2	27	23	14	16	20	54	20	11	14	0	36	41	9	11	2
16	27	32	20	11	9	18	39	20	14	9	7	23	23	34	14	27	27	14	30	2
18	34	18	14	18	15	18	23	25	27	7	2	11	5	45	36	18	11	16	27	27
20	27	36	16	16	5	18	18	30	20	14	9	20	18	36	16	16	36	9	25	14
22	43	27	14	9	7	16	14	20	18	31	9	20	16	34	18	39	16	9	30	5
25	7	16	23	25	30	23	27	30	11	9	9	25	30	20	16	7	11	27	34	20
27	36	39	14	9	2	48	25	18	5	5	14	23	34	27	2	18	34	14	23	11
29	9	14	11	25	41	14	18	27	20	20	7	23	16	20	34	25	9	11	23	32
32	32	43	16	0	9	43	25	23	2	7	9	25	32	32	2	23	32	20	16	9
36	77	14	5	2	2	39	20	11	23	7	20	5	14	39	25	68	16	5	9	0
41	30	43	11	11	5	39	32	18	7	5	11	16	27	30	16	18	34	23	18	7
44	16	32	34	11	7	45	36	16	2	0	9	27	30	27	7	14	30	32	18	7
48	16	34	23	23	5	39	27	11	16	7	23	23	16	32	5	25	25	20	20	9
49	39	23	20	7	11	25	25	18	18	14	18	27	27	16	11	30	26	23	14	7
54	5	9	32	14	41	14	16	54	16	0	43	25	18	11	2	0	12	35	42	12
57	9	19	28	33	12	23	33	30	14	0	51	25	21	2	0	7	19	33	28	14
58	5	34	23	18	20	23	27	30	11	9	45	36	11	5	2	5	30	23	18	25
60	11	39	25	18	7	11	39	18	23	9	25	45	23	5	2	14	41	23	18	5
61	63	23	7	2	5	27	25	9	11	27	73	18	5	5	0	68	16	9	2	5
75	2	7	34	20	36	14	20	39	23	5	34	23	25	14	5	2	14	30	25	27
W	7	7	18	20	48	11	9	52	14	14	50	14	23	5	9	11	14	34	16	25

TABLE XI

PERCENTAGES OF RESPONSES FOR VARIOUS DEGREES OF JUDGMENT

SET E

Gel No.	Temperature					Tragedy					Comedy					Melodrama					Romance				
2	7	18	41	16	18	2	0	18	20	59	27	30	18	7	18	7	2	30	27	34	7	11	23	20	39
6	50	36	11	2	0	5	16	18	32	30	9	41	30	11	9	14	41	14	14	18	18	27	9	25	20
8	14	57	14	14	2	0	16	27	27	30	18	32	25	20	5	2	25	32	18	23	20	30	18	23	9
9	16	64	14	5	2	2	11	14	32	41	14	30	32	16	9	14	32	23	18	14	20	25	16	18	20
10	68	30	0	2	0	7	20	11	25	36	16	23	25	27	9	27	32	11	18	11	18	25	9	25	23
11	73	25	5	0	0	23	30	14	16	18	9	29	22	16	24	42	49	9	5	2	18	7	20	23	32
16	0	2	20	45	32	36	41	14	9	0	0	5	32	23	41	25	39	11	16	9	34	30	16	9	11
18	11	7	18	34	30	34	11	20	23	11	0	5	18	20	57	20	36	23	14	7	41	20	14	16	9
20	7	11	25	34	23	43	25	20	9	2	2	11	11	30	45	39	34	14	9	5	27	27	25	13	6
22	23	25	23	18	9	45	25	14	9	5	2	9	9	34	43	43	30	9	11	2	16	14	14	30	25
25	0	0	25	54	20	5	30	23	16	27	9	14	25	32	20	11	18	34	14	23	18	32	18	20	11
27	2	7	23	52	16	20	43	7	14	16	5	16	14	37	28	20	32	14	20	14	43	23	23	9	2
29	2	2	7	39	50	36	16	25	18	5	5	7	25	23	41	18	18	27	23	14	25	23	14	16	23
32	2	5	20	45	27	25	36	27	7	5	0	9	34	30	27	30	30	18	9	14	48	16	18	11	7
36	9	7	18	20	48	61	30	7	2	0	0	5	9	16	70	54	25	7	7	7	45	16	7	18	14
41	0	2	27	50	20	25	41	11	14	9	0	5	23	32	41	30	39	14	9	9	39	23	20	11	7
44	0	7	25	50	18	16	23	32	18	11	5	16	34	34	11	16	25	30	18	11	25	34	18	18	5
48	2	14	11	41	32	20	20	25	18	16	5	16	23	23	34	27	18	25	25	5	16	30	9	23	23
49	2	7	47	23	21	30	23	20	16	11	5	11	14	32	39	32	39	11	9	9	14	23	20	18	25
54	16	20	36	18	9	0	9	20	25	45	39	36	14	9	2	9	9	16	32	34	7	14	14	23	43
57	26	33	40	2	0	2	12	16	30	40	49	30	14	7	0	5	2	14	23	35	2	28	14	28	28
58	36	54	7	2	0	0	5	18	20	56	41	34	14	7	5	11	18	30	25	16	2	20	16	32	30
60	45	52	2	0	0	7	16	16	34	27	18	43	23	5	11	16	36	30	9	9	0	26	19	19	36
61	95	2	2	0	0	25	16	14	18	27	23	27	9	20	20	45	34	7	5	9	18	9	11	18	43
75	5	16	27	36	16	0	9	23	30	39	9	30	23	23	16	2	11	34	16	36	7	16	23	23	32
W	11	16	34	14	25	5	2	20	27	45	27	25	27	11	9	2	9	27	32	30	2	11	11	36	39

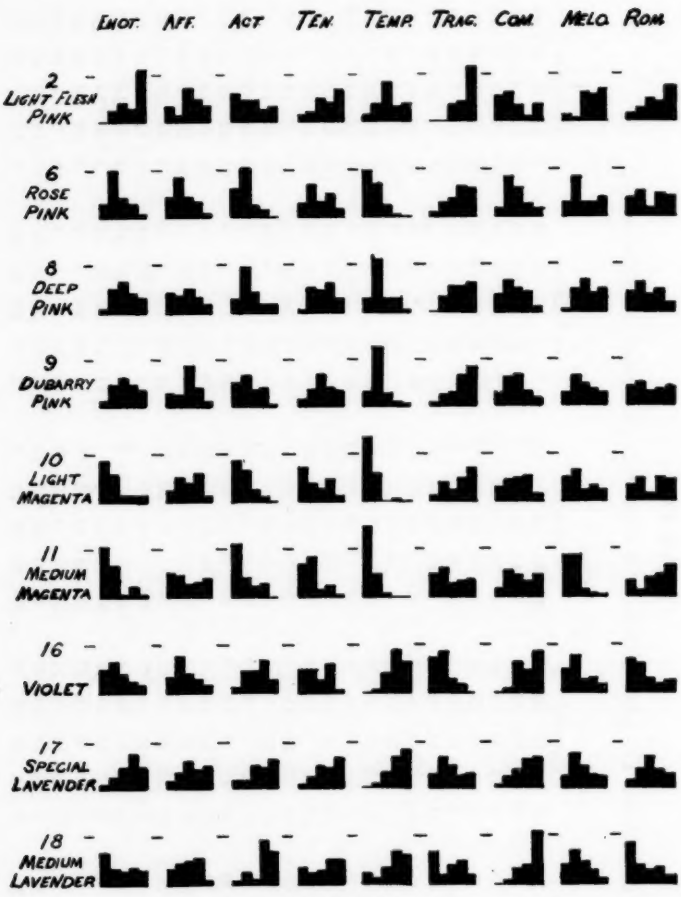


Figure 5

The distributions of the audience responses on the various scales. Set *E*.

The results of the ratings on the various scales are given in Tables IX, X and XI, and in figures 5, 6 and 7. An inspection of these data shows at once a negative relationship between comedy and tragedy, a correlation of "hot"

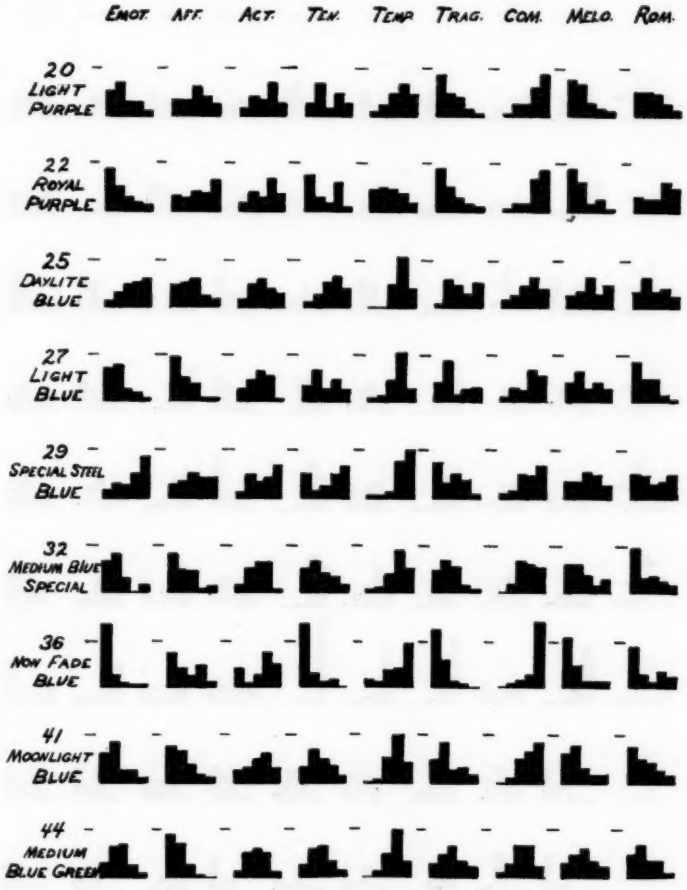


Figure 6

The distributions of the audience responses on the various scales. Set *E*.

colors with long wave-lengths, and a relation of comedy with "warm" colors. The various correlations are given in Table XII.

An examination of the Table of medians (X), the inter-

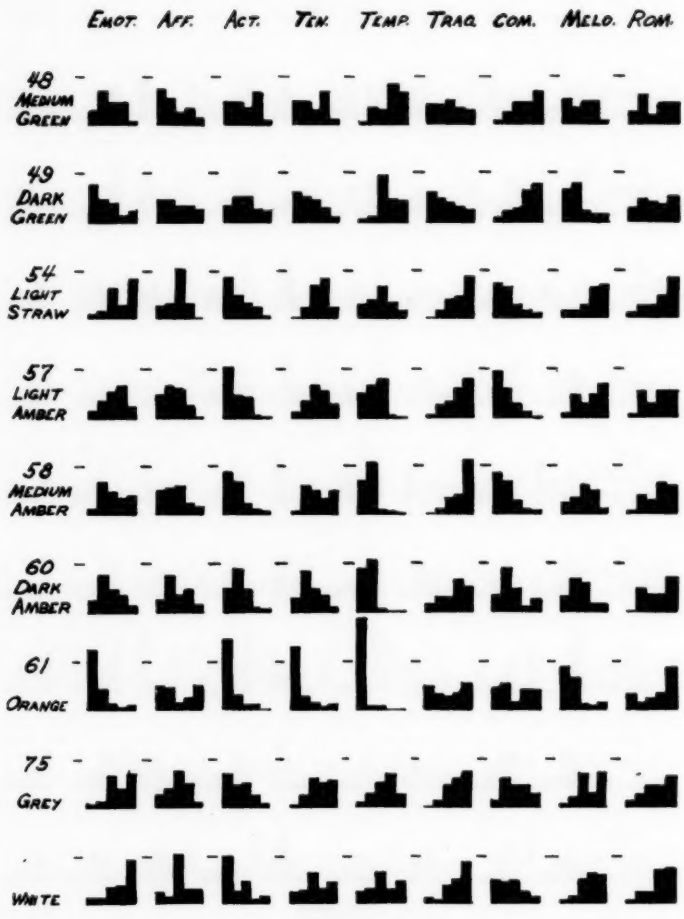


Figure 7

The distributions of the audience responses on the various scales. Set *E*.

correlations (XII) and the bar-diagrams brings to light at once the realization that the audience reaction to a color is comprised of three aspects: the reaction to hue, the reaction to saturation and the reaction to brightness. The rela-

TABLE XII

INTER-CORRELATIONS OF THE MEDIANS OF THE SCALE VALUES, AND CORRELATIONS OF THE SCALE VALUES WITH PURITY, INTENSITY, SATURATION AND BRIGHTNESS

SET E

	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Emot.	——	0.45	—0.03	0.86	0.11	0.63	—0.43	0.85	0.43
Affect.	——	——	0.11	0.44	—0.03	0.11	0.07	0.14	0.42
Act.	——	——	——	0.08	0.77	—0.72	0.81	—0.29	—0.64
Ten.	——	——	——	——	0.29	0.50	—0.30	0.81	0.16
Temp.	——	——	——	——	——	0.51	0.70	—0.01	—0.63
Trag.	——	——	——	——	——	——	—0.90	0.76	0.69
Com.	——	——	——	——	——	——	——	—0.59	—0.70
Melo.	——	——	——	——	——	——	——	——	0.39
Rom.	——	——	——	——	——	——	——	——	——
Purity	0.66	0.45	0.11	0.73	0.28	0.32	—0.04	0.61	0.09
Intensity	—0.69	—0.15	0.66	—0.55	0.46	—0.93	0.90	—0.82	—0.66
$r_{12.3}$ (2)	0.64	0.43	0.37	0.69	0.51	0.06	0.60	0.67	—0.17
$r_{13.2}$ (3)	—0.67	—0.01	0.64	—0.49	0.60	—0.92	0.95	—0.84	—0.89
Saturation	0.77	0.42	—0.03	0.84	0.23	0.45	—0.23	—0.77	—0.19
Brightness	0.08	0.17	0.45	0.31	0.34	—0.20	0.35	—0.02	—0.37

tion of purity and intensity to the various scales is indicated in Table XII. The coefficients of correlation in this table may be thought of as relatively free from the influence of hue since the hue varied from measurement to measurement. The correlation of scale rating to purity is not, however, independent of intensity since purity and intensity, as has been pointed out above, are negatively correlated to the extent of —0.32. The question then arises as to the relation of judgment to purity if intensity could be kept constant. The rows labled $r_{12.3}$ and $r_{13.2}$ give indications of the probable values of the correlations between scale medians and purities, if intensities were kept constant; and between scale medians and intensities, if purities were kept constant. In the third pair of rows the correlations of scale medians with saturation and brightness are given. It will be remembered that saturation is "purity-as-seen," and that brightness is "intensity-as-seen." It was seen from Table VIII that purity and saturation were highly correlated (0.82) but that intensity and brightness showed practically no relationship (0.16). The question then arises as to whether the audience reacted to the real brightness or to their mistaken rating of it. In other words, when they rated a brightness low when it was really relatively high would their reaction to the color be to one of high intensity such as it really was, or to one of low intensity such as they thought it was? A comparison of the correlations indicates that intensity was a determining factor in judgment while brightness had little to do with the scale judgment.[1] In other words, the audience reacted to the "real" characteristic of the color rather than to what they *thought* about it.

An inspection of the correlations of scale vs. scale in Table XII brings to light some interesting relationships. In the first place it will be seen that "comedy" and "tragedy" are negatively correlated (—0.90) to an extent which clearly indicates that those colors which were considered suitable for "comedy" were not considered suitable for "tragedy," a statistic which indicates the validity of the ratings. The relationship of "temperature" to "tragedy" and to "comedy" indicates again the validity of the practice of using "cool"

[1] This same effect may be demonstrated by arranging the colors of Set *D* in rank-order according to "temperature" and then arranging the same colors in rank-order according to the magnitude of the "red" coefficient, assigning an arbitrary position to "purple." It is found that the two rank-orders coincide. This would indicate that the audience reacts to the red in various hues as "warm" although it is doubtful if in violets, for instance, they are aware of the presence of a red component.

TABLE XIII

AVERAGE POSITIONS AND THEIR PRECISIONS OF VARIOUS COLORS ON THE ADJECTIVE SCALE

SET E

Gel No.	Mean	Precision %
2	1.93	52.6
6	1.04	51.3
8	2.13	73.8
9	2.06	69.0
10	8.79	63.9
11	7.30	52.6
16	4.00	65.1
17	4.12	60.9
18	3.89	70.0
20	4.37	49.2
22	5.76	56.0
25	3.16	63.2
27	3.05	52.1
29	3.87	68.5
32	4.23	48.8
36	5.54	60.8
41	3.93	51.1
44	2.81	50.2
48	3.11	33.0
49	5.72	38.6
54	1.06	70.9
57	1.30	79.3
58	8.84	79.6
60	8.42	64.2
61	7.98	76.0
75	2.61	———
W	8.97	59.0

hues for "tragedy" and "warm" hues for "comedy." We may, from the table, make the following tentative generalizations:

Tragedy:	cold hues, any saturation, low brightness.
Comedy:	hot hues, high saturation, high brightness.
Melodrama:	any hues, high saturation, low brightness.

Romance:	cold hues, any saturation, low brightness.
High saturation:	high emotionality, high tension, high temperature, high comedy and high melodrama.
High brightness:	low emotionality, high activity, low tension, high temperature, low tragedy, high comedy, low melodrama and low romance.

The "zero" correlations, it should be remembered, indicate *no* relationship, not an inverse one.

The fact that "affectivity" is unrelated to the other scales should be noted, as should the high relation of "emotional-

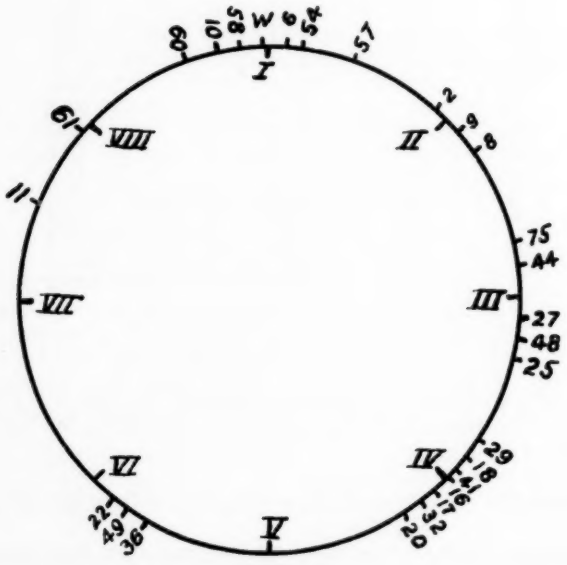


Figure 8

The positions of the various gels on the adjective scale. Roman numerals refer to groups on the adjective list (fig. 12) and arabic numerals to gel numbers as given in Table V.

ity" and "tension." The relation of all the scales to hue may be best seen from the Table of medians (IX).

The check-lists for adjectives showed an average response per person of 7.8 adjectives with a range from 2.4 to 15.5. Only 30 of the 1,180 lists checked showed no response with a maximum of four such records for one color. The frequency of response seems to be more a matter of individual difference in the subjects than in the characteristics of the color. The average response per color was 7.8 adjectives with a range from 5.0 to 10.0. The relation of number of responses to purity is small and positive (0.34), and to intensity relatively large and negative (—0.59).[1] A plot of the number of responses against hue gave no significant relationship. Differences in number of responses, therefore, we may attribute first to individual inclination of the subjects, and second to a tendency in all subjects to be more prolific in their responses to dim intensities; or, conversely, to be more specific in their responses to high intensities.

The responses may be tabulated in two ways. In the first method we seek the typical response for each color, and in the second the typical color for each list of adjectives. A preliminary survey of the relations of purity and intensity to the adjective list showed no demonstrable relationship. The typical position of each color on the adjective scale is shown in Table XIII.[2]

In figure 8 the mean ratings of Table XIII are plotted on a circular scale which represents the adjective scale. The positions of the various adjective lists are indicated by Roman numerals and the gels are shown by number and color designation. It will be seen that the colors tend to cluster about certain scale nodes. It is possible, therefore, to group the colors about the various scale dimensions and to find the mean dominant wave-length for the colors in each group. (This calculation is difficult, depends on a number of as-

[1] These two correlations are partials; the first with intensity partialed out and the second with purity partialed out. The original correlations are rank-order coefficients.

[2] If the adjective lists are considered as forming an eight-point circular scale, then all of the lists, excepting that for "grey" (#75), satisfy the criterion for transformation to a linear scale[3] and have been so treated. The measure of precision is the percentage of responses falling on one side of the diameter, that is, the percentage of responses from which the mean is calculated. This corresponds, roughly, with the measure proposed for circular scale treatment.

[3] Ross, R. T., "A Statistic for Circular Scales," *Jour. Educ. Psychol.*, (in press).

sumptions, and will not be reproduced here.) The results of such a procedure are as follows:

Adjective Group	No. of Gels	Mean Wave-Length	Color
I	5	587	Y-O
II	3	513c	R-P
III	5	510	B-G
IV	7	475	B
V	0		
VI	3	489	B-G
VII	1	515	P
VIII	2	599	O

Coarse as these measures are, they indicate a tendency for the purples, reds, oranges and yellows to be found in the "dramatic" (VII), "soaring" (VIII), "bright" (I) and "sparkling" (II) groups, and for the greens, blue-greens, and blues to be joined in the "delicate" (III), "calm" (IV), "sad" (V) and "dignified" (VI) groups. This corresponds very well to the results found from the scales discussed above.

A review of the findings from Set *E* leads one again to the conclusion that in spite of large individual differences in judgments of colors, there are certain general trends which are sufficiently definite to be of significance. Some of the

TABLE XIV

MEDIAN VALUES FOR THE DIFFERENT SCALES FOR ALL COLORS

SET F

Gel No.	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
2	28.0	74.0	32.0	27.0	37.5	20.0	53.0	22.5	76.6
6	64.0	60.0	72.0	52.5	76.6	40.0	68.0	62.5	60.0
9	64.3	65.7	57.5	38.3	54.3	28.6	65.0	35.0	76.0
11	88.0	52.0	66.0	75.0	91.5	72.9	32.5	84.0	40.0
16	60.0	78.3	26.0	70.0	24.0	79.5	23.3	50.0	76.6
17	34.3	52.5	33.3	50.0	23.7	65.0	27.0	55.0	40.0
20	65.7	65.0	35.7	65.0	36.6	77.0	32.0	72.5	62.5
22	85.0	45.0	47.5	74.4	61.4	83.3	28.0	81.8	64.0
26	22.5	38.5	28.0	62.0	10.0	80.0	20.0	42.5	20.0
36	83.3	75.0	31.4	80.0	18.3	88.9	22.0	70.0	68.0
41	70.0	83.3	45.0	70.0	35.0	78.0	37.5	55.0	85.0
44	72.0	77.5	46.6	71.7	33.3	72.2	40.0	66.6	63.3
48	55.0	55.0	34.0	65.0	22.0	70.0	30.0	68.3	35.0
49	72.0	66.0	46.6	66.6	34.0	77.5	36.0	76.0	50.0
58	52.5	60.0	70.0	48.0	78.8	23.3	86.6	58.0	51.7
60	70.0	66.6	78.3	51.7	81.4	30.0	78.0	50.0	30.0
61	73.3	56.6	81.4	60.0	90.0	35.0	82.5	75.0	40.0
67	90.0	55.0	80.0	78.3	94.2	74.0	53.3	84.0	26.6
75	27.7	32.5	43.3	25.0	16.0	26.3	50.0	23.3	20.0
W	25.0	40.0	61.0	30.0	30.0	35.0	55.0	30.0	20.0

TABLE XV

PERCENTAGES OF RESPONSES FOR VARIOUS DEGREES OF JUDGMENT

SET F

Gel No.	Emotionality					Affectivity					Activity					Tension				
2	9	4	17	35	35	35	35	17	9	4	4	9	17	48	22	4	9	9	35	43
6	26	30	35	9	0	22	26	44	9	0	30	39	13	13	4	13	22	35	26	4
9	26	35	13	22	4	26	39	26	4	4	5	41	32	14	9	0	17	26	44	13
11	65	30	4	0	0	13	22	22	30	13	39	22	13	17	9	39	22	17	13	9
16	35	13	13	30	9	44	30	9	9	9	9	4	0	35	39	39	17	17	26	0
17	13	4	13	39	30	13	22	35	17	13	0	17	22	30	30	17	22	26	22	13
20	30	35	13	22	0	35	17	26	13	9	9	9	17	44	22	22	39	17	13	9
22	61	22	9	4	4	22	26	4	30	17	4	30	26	22	17	26	44	13	9	9
26	22	4	9	17	48	0	9	35	35	22	9	9	17	30	35	22	30	17	17	13
36	52	26	9	13	0	48	22	13	13	4	13	4	4	61	17	48	26	13	9	4
41	35	30	26	9	0	52	30	13	4	0	13	17	26	35	4	26	39	9	17	9
44	30	30	22	9	0	44	26	17	13	0	17	26	13	44	0	26	39	22	4	9
48	26	22	17	17	17	30	17	17	22	13	9	13	13	48	17	17	35	22	17	9
49	30	35	17	9	9	26	35	26	13	0	17	17	22	30	13	30	26	17	17	9
58	4	30	39	13	13	17	30	22	26	4	39	39	9	9	4	13	17	35	26	9
60	22	52	13	9	4	35	22	0	35	9	44	44	4	4	4	9	17	44	9	22
61	39	22	26	9	4	26	17	26	22	9	52	30	9	9	0	17	30	22	17	13
67	74	13	4	0	29	26	22	17	4	30	48	22	9	13	9	44	39	9	0	9
75	4	4	4	52	35	0	9	26	39	26	13	4	35	23	22	9	9	9	35	39
W	4	4	30	13	48	4	13	30	22	30	14	36	27	5	18	4	17	26	22	30

TABLE XVI

PERCENTAGES OF RESPONSES FOR VARIOUS DEGREES OF JUDGMENT

SET F

Gel No.	Temperature					Tragedy					Comedy					Melodrama					Romance				
2	0	17	22	44	17	9	9	9	21	52	17	13	35	17	17	0	13	17	22	48	44	26	17	9	4
6	39	44	13	4	0	17	9	22	30	22	30	35	17	13	4	4	48	17	22	9	26	22	26	17	9
9	0	30	44	26	0	0	22	9	44	26	26	26	13	22	13	9	13	17	30	30	39	44	13	4	0
11	74	22	0	0	4	17	39	17	13	13	9	13	13	26	39	57	17	4	13	9	9	26	13	17	35
16	0	9	13	35	44	50	27	14	5	5	0	0	26	26	48	13	26	17	22	22	44	17	9	17	13
17	0	0	9	52	39	26	26	13	30	4	0	0	26	30	44	4	35	22	17	22	22	17	9	30	22
20	4	13	26	44	13	44	35	9	9	4	4	13	13	39	30	35	35	13	9	9	26	35	13	9	17
22	9	44	22	22	4	57	17	17	0	9	9	9	13	35	35	52	22	13	9	4	22	35	9	13	22
26	0	0	9	26	65	48	9	17	17	9	0	4	26	17	52	9	13	30	30	17	4	17	13	13	52
36	9	0	0	35	57	84	4	13	0	0	0	0	17	35	48	30	35	13	9	13	44	22	17	9	9
41	5	9	23	41	23	44	30	4	13	9	4	13	26	35	22	22	22	22	9	26	61	13	4	13	9
44	4	4	22	61	9	17	44	13	13	13	13	9	26	39	13	26	30	13	17	13	30	22	17	22	9
48	0	4	13	35	48	26	30	9	22	13	13	9	22	17	39	30	39	9	17	4	9	17	13	26	35
49	9	4	22	48	17	44	26	13	9	9	9	22	9	30	30	39	44	4	9	4	17	22	17	22	22
58	44	39	17	0	0	0	4	22	26	48	65	22	0	9	4	9	35	22	13	22	13	13	39	4	30
60	52	44	4	0	0	0	17	13	39	30	44	35	4	13	4	30	9	26	22	13	9	26	9	26	30
61	83	13	4	0	0	9	26	13	17	35	52	9	22	9	9	44	30	4	9	13	4	35	9	13	39
67	91	9	0	0	0	35	30	13	13	9	26	13	17	26	17	57	26	13	0	4	9	17	9	22	44
75	0	4	4	30	61	4	9	13	44	30	9	26	22	4	39	4	0	22	26	48	4	4	17	22	52
W	0	13	26	17	44	13	17	9	26	35	13	26	17	17	26	9	9	26	22	35	0	13	17	17	52

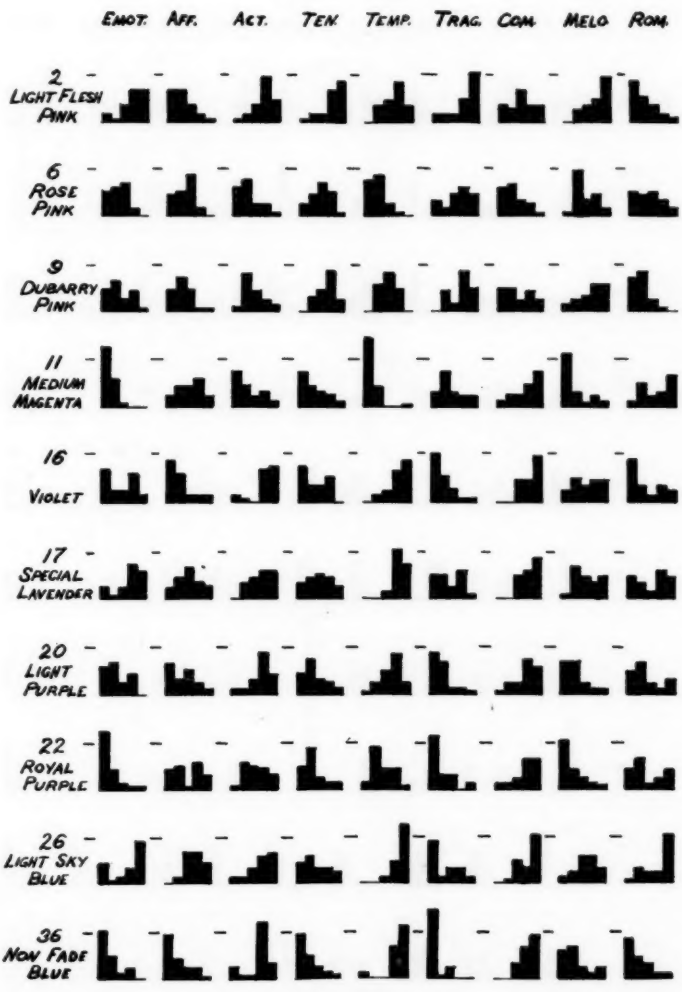


Figure 9

The distributions of the audience responses on the various scales. Set *F*.

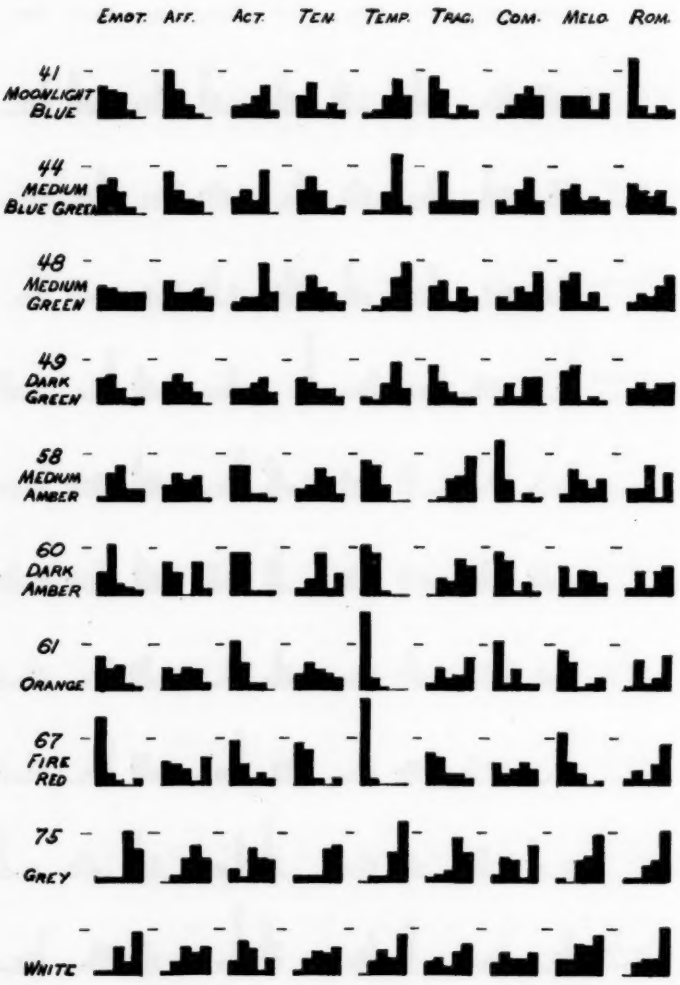


Figure 10

The distributions of the audience responses on the various scales. Set *F*.

TABLE XVII

HUES OF THE GELATINES AS RATED BY THE AUDIENCE

SET F

Gel No.	Gel Name	Color Rating by Audience	Color Designation
2	Lt. Flesh Pink	RP	R
6	Rose Pink	R	R
9	Dubarry Pink	R	P
11	Med. Magenta	RP	RP
16	Violet	BV	B
17	Spec. Lavender	V	VP
20	Lt. Purple	VP	VP
22	Royal Purple	VP	VP
26	Lt. Sky Blue	B	B
36	Non-Fade Blue	B	B
41	Moonlite Blue	B-BG	BG
44	Med. Blue-Green	G-BG	G-BG
48	Med. Green	G	G
49	Dk. Green	G	G
58	Med. Amber	YO	YO
60	Dk. Amber	O	O
61	Orange	O	RO
67	Fire Red	R	RO
75	Grey	YG	Y

TABLE XVIII

CORRELATIONS OF PHYSICAL CHARACTERISTICS OF DIFFERENT COLORS (PURITY AND INTENSITY) WITH JUDGMENTS OF SATURATION AND BRIGHTNESS

	Purity	Intensity	(—0.43)
Saturation	0.86	—0.59	
Brightness (0.78)	0.75	—0.20	

Coefficients in the body of the Table are partials. The correlation of Saturation vs. Brightness is 0.78, of Purity vs. Intensity is —0.43.

trends are in directions which lead one to consider the judgments as valid, some have been stated before in the form of artistic intuitions and some are indicative of relationships which have not heretofore been stated explicitly. The general consistency of the ratings from the scales and from the adjective lists, demonstrates a consistency of judgment which is not demonstrable statistically, but which an inspec-

TABLE XIX

INTER-CORRELATIONS OF THE MEDIANS OF THE SCALE VALUES, AND CORRELATIONS OF THE SCALE VALUES WITH PURITY, INTENSITY, SATURATION AND BRIGHTNESS

SET F

	Emot.	Affect.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Emot.	——	0.27	0.44	0.80	0.56	0.42	0.01	0.83	0.25
Affect.	——	——	—0.35	0.25	0.08	0.12	0.05	—0.04	0.77
Act.	——	——	——	—0.04	0.82	—0.33	0.61	0.36	—0.28
Ten.	——	——	——	——	0.13	0.83	—0.49	0.79	0.24
Temp.	——	——	——	——	——	—0.27	0.64	0.45	0.08
Trag.	——	——	——	——	——	——	—0.77	0.50	0.21
Com.	——	——	——	——	——	——	——	—0.14	—0.12
Melo.	——	——	——	——	——	——	——	——	0.02
Rom.	——	——	——	——	——	——	——	——	——
Purity (2)	0.78	0.26	0.53	0.54	0.57	0.22	0.23	0.71	0.07
Inten. (3)	—0.66	—0.25	0.24	—0.86	0.08	—0.86	0.63	—0.70	—0.35
$r_{12.3}$	0.73	0.17	0.83	0.74	0.67	—0.33	0.71	0.64	—0.09
$r_{13.2}$	—0.56	—0.16	0.61	—0.88	0.45	—0.86	0.83	—0.62	—0.36
Saturation	0.85	0.09	0.43	0.72	0.47	0.45	0.00	0.87	—0.01
Brightness	—0.72	—0.02	—0.77	—0.45	—0.74	—0.04	—0.41	—0.75	—0.16

TABLE XX

AVERAGE POSITIONS AND THEIR PRECISIONS OF VARIOUS COLORS ON THE ADJECTIVE SCALE

SET F

Gel No.	Mean	Precision %
2	2.84	83.4
6	1.75	72.9
9	2.77	96.0
11	7.72	34.0
16	3.83	73.9
17	4.01	69.4
20	4.10	53.2
22	5.78	63.3
26	4.83	72.9
36	5.14	54.7
41	3.57	61.5
44	2.72	46.9
48	3.72	41.4
49	5.37	24.2
58	1.26	84.8
60	8.90	84.6
61	8.61	82.9
67	7.48	83.2
75	3.55*	——
W	6.22*	——

* No precision measure has been given since the responses were not amenable to transformation to a linear scale.

tion of the results indicates as significant. A study of the findings on both scales and lists leads one to the conclusion that hue, saturation and brightness all play a part in the reaction to color, and that the central tendencies of reactions are consistent and meaningful.

SET F: RESPONSES FROM A TRAINED AUDIENCE

The procedure of Set *F* was exactly like that for Set *E* except that the 23 subjects used in Set *D* were used, and only 20 colors, 18 of which were used with Set *E* and 2 were new ones.

The percentage distributions are given in Table XIV and the medians in Tables XV and XVI. The distributions are shown graphically in figures 9 and 10. Two results are of especial interest. Gel #26 is blue and, therefore, should be rated as cold; its purity is low, and from the correlation of purity and temperature found in Set *E* (0.51), we should ex-

pect it to be rated as low in temperature; its relative intensity is 35.9 which falls between Gels #17 (Special Lavender) and #25 (Daylight Blue) which received ranks of 4 and 7 on temperature, on the basis of which we should expect Gel #26 to rate low in temperature. The three predictions from Set *E* all point in the direction of low temperature; reference to Table XIV will show that it was rated as the coldest color in the group.

A similar treatment of the results on Gel #67 would lead us to expect that it would be rated at a higher temperature than Gel #61 and this is, indeed, the case as reference to the Table will show. It would appear that the results of Set *E* are of predictive value when applied to another situation.

The ability of this group to specify hue is shown in Table XVII. In only one case is there a significant disparity (Gel #9) and that not serious. The data indicates that median

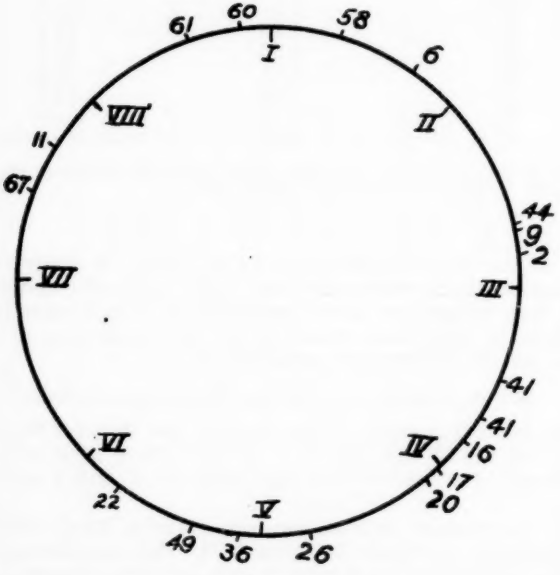


Figure 11

The positions of the various gels on the adjective scale. Roman numerals refer to groups on the adjective list (fig. 12) and arabic numerals to gel numbers as given in Table V.

judgments of hue are in agreement with the physical characteristic of the color.

The ability of the group to judge saturation is excellent, but their judgment of brightness is fallible as Table XVIII shows.

It would appear either that the subjects have confused brightness with some other characteristic of the color, or that brightness judgments are so influenced by the purity of the color that colors of high saturation are judged bright and those of low saturation as dim. It is impossible to choose between the alternatives from the data.

The inter-correlations of the various scales together with the correlations of median scale judgments with purity and intensity are shown in Table XIX. The rows labeled $r_{12.3}$ and $r_{13.2}$ give the correlation of scale medians with purity if relative intensity be held constant, and with relative intensity if purity be held constant, respectively. Here again we see the negative relationship of tragedy and comedy, the warm colors associated with comedy (though cool colors and tragedy are not so highly indicated), the relation of comedy with high activity, high saturation and high brightness and tragedy with low brightness. The general impressions gained from this group are much the same as those obtained with Set *E*, but the small number of cases (23) makes the median responses less precise.

The adjective lists were treated as in Set *E* and mean positions on the hypothetical circular scale calculated for each gel. All sets of data, excepting those for grey (#75) and white, satisfied the criterion for transformation to a linear scale. The mean positions, together with measures of their precisions, are given in Table XX and shown graphically in figure 11.

The interpretation of the data from Set *F* is not as significant of itself as by comparison with Sets *D* and *E*. These comparisons are discussed in the following section.

COMPARISONS OF SETS D, E AND F.

The comparisons of major interest are between Sets *D* and *F* where the same subjects dealt with two different problems, and between Sets *E* and *F* where two different groups were presented with 18 identical gels under the same experimental conditions.

The first question which arises in a comparison of Sets *D* and *F* concerns the consistency of responses. The same 23 subjects took both tests. In Set *D* they were asked to rate

each of eight colors on the nine scales of the test. In Set *D* only color names were given. In Set *F* this same group of subjects, a month later, were given colors which corresponded with the names which had been given in Set *D* and asked to rate the colors seen on the same scales as were used in Set *D*. Since there were only eight colors and nine scales, 72 responses were given by each subject. If the median response for the group is calculated for each of the 72 ratings on Set *D*, and for the 72 ratings on the corresponding colors on Set *F*, these medians may be correlated. If the group is completely consistent, a coefficient of correlation of 1.00 would be expected. The product-moment coefficient of correlation is 0.76 which indicates a high degree of consistency; in other words, the group reacted to the colors as they said they would.

Still another comparison, much less reliable than the first, may be made between the consistency of the two sets with regard to reactions to any given color. Since there are only nine scales, the coefficients are not too reliable, but they are indicative. The coefficients (ρ) are given in Table XXI. The coefficients indicate that the group reacted to the ac-

TABLE XXI

COEFFICIENTS OF CORRELATION FOR SCALE MEDIANS ON SET E AND SET F FOR EACH COLOR

Gel No.	ρ
2	0.36
6	0.80
9	0.10
11	0.82
16	0.77
17	0.78
20	0.88
22	0.78
36	0.82
41	0.86
44	0.65
48	0.55
49	0.82
58	0.92
60	0.87
61	0.62
75	0.67
W	0.78

tual colors as they did to the color names with remarkable consistency, except in the case of "grey" (#75) where the prediction was inadequate. It is interesting to note that in the case of the adjective lists the responses were very diffuse for "grey" while they showed high consistency for the other colors. "Grey" seems to be a color which carries with it little specificity of response. A review of the bar-diagrams of Sets *E* and *F* shows that in the presence of a grey stimulus, the tendency is to consider "grey" as a color unsuited for practically everything. There seems to be little crystallized opinion regarding this color.

Still a third type of comparison may be made by comparing the consistency of the group on various scales. Such a comparison gives the following coefficients of correlation based on the eight colors:

Emot.	Affect.	Act.	Ten.	Tem.	Trag.	Com.	Melo.	Romance
0.88	0.86	0.74	0.24	1.00	0.62	0.64	0.79	0.93

A final comparison between Sets *D* and *F* may be made by examination of Tables III and XIX for the consistency of inter-scale correlations. If the 36 coefficients of Set *D* are correlated with the corresponding 36 for Set *F* a coefficient of correlation of 0.74 is obtained which indicates, in view of the number, a significant consistency of response.

It would appear from these results that we are dealing with a relatively reliable phenomenon. The correlations in Table IV when compared with those in Table III indicate that the variability in judgment in any one individual is so great as to obscure any trends, but that when the judgments of a group of individuals are considered and the average (median) judgment taken as representative of the group, these representative judgments show a stability which makes audience reaction amenable to analysis and prediction when individual judgments cannot be so treated. Inasmuch as this study is interested in the nature and stability of audience reactions the data indicate the possibility of measurement and prediction of responses.

The various comparisons of data from Sets *E* and *F* indicate a substantial consistency of response. As is the case with most psychophysiological data, the variability between groups is greater than that between results from the same groups on different occasions. It will be remembered that Set *E* is a large group (44), unsophisticated in the work of the theater, while Set *F* is a smaller group (23) of subjects trained in the theater arts.

A comparison of Table VII with Table XVII shows that the trained group is no better able to name colors than is the untrained group. Both groups are equally able to judge saturation correctly, but both groups have difficulty with the concept of brightness, and to about equal degrees. The similarities in the coefficients of Tables VI and XVIII indicated that probably some factor other than mere misunderstanding is operative.

Sets *E* and *F* had 18 colors in common, each rated on nine scales. It is possible to correlate the median values on the 162 color-scale ratings. The product-moment coefficient of correlation is 0.80, which is sufficiently high to guarantee consistency of responses between different groups.

It is also possible to calculate the correlations of scale ratings for each color. Since only nine scales were used, these coefficients are not very reliable, but they may serve a comparative purpose. The coefficients are given in Table XXI. The median coefficient is 0.78 with individual coefficients ranging from 0.10 for "Dubarry Pink" to 0.92 for "Medium Amber." The extremely low correlation for "Dubarry Pink" is probably the result of its peculiar utility as a theatrical gel, a fact which would lead the trained group to consider it from a different point of view than would the untrained group.

In like manner, the correlation of color medians for each scale may be computed. These coefficients, based on 8 colors, are as follows:

Emot.	Aff.	Act.	Tens.	Tem.	Trag.	Com.	Melo.	Rom.	Median
0.75	0.46	0.76	0.75	0.89	0.95	0.88	0.78	0.54	0.76

The highest agreements are for judgments of suitability for "tragedy" and of "temperature." The least agreement is on the "affectivity" (pleasantness) of colors and their "romantic" values.

A comparison of the two Tables of correlations, (XII) and (XIX), for Sets *E* and *F* gives a correlation between the two sets of coefficients of 0.75, which is essentially the same as that found between *D* and *F*. An inspection of the correlation with purity and relative intensity indicates the same significant relationship.

The results from Sets *D*, *E* and *F* indicate that as far as ratings on the scales are concerned, a significant correlation between the ratings of various audiences may be expected. This consistency is quantitatively of the order of 0.75 with a probable error of the order of 0.10.

The comparison of the responses on the adjective check-lists presents approximately the same picture. If from Tables XIII and XX we correlate the rank-order of the various colors around the circular scale of adjectives, we obtain for the 16 colors (grey and white are omitted since they cannot be transferred to linear scales), a correlation coefficient of 0.98 which indicates almost complete duplication of the results.

If the 18 common colors in Tables XIII and XX are considered, the subjects of Set *E* checked an average of 7.74 adjectives per color and the subjects of Set *F* an average of 5.84 per color. If the number of responses per color are correlated, a coefficient of 0.65 is obtained. These data indicate a tendency on the part of the trained subjects to be more specific in their responses in the sense of limiting their responses to a fewer number of descriptive adjectives.

If the precisions of the two groups are compared from Tables XIII and XX it will be seen that Set *E* had an average precision of 56.9% and Set *F* an average precision of 64.2% with a correlation between the two sets of measures of 0.81. These data indicate that not only do the subjects of Set *F* use fewer adjectives, but those which they do use tend to cluster more about the same point on the scale; the trained audience is more parsimonious in their use of descriptive adjectives and more precise in their description. On the other hand it must be kept in mind that the average responses of the two groups in the adjective scales are practically identical.

HUE, TEMPERATURE AND DESCRIPTIVE ADJECTIVES

In the foregoing discussion there has been no consideration of the relation of the various scales with the responses on the lists of descriptive adjectives. The following considerations are based on the data from Set *E*, the group of 44 students relatively ignorant of theater practice.

In trying to find relations between the various colors used and the adjectives which are chosen to describe them, we encounter two very difficult problems. In the first place, the scale of adjectives is a circular scale. The adjectives should be arranged as shown in figure 12 in order to see their essential relationships. When the adjectives are so arranged, we may consider each group as defining one of eight equally spaced scale divisions around a circle, and we can, as shown in Table XIII, calculate the position on the circle for each color. For instance Gel #16 (Violet) is best described by

Figure 12

The adjective lists in figure 4 arranged as a circular scale.

the adjectives in group IV, and 65.1% of the total number of adjectives checked tend in this direction. On the other hand, the best description of Gel #36 (Non-Fade Blue) falls about half way between groups V and VI, and 60.8% of the responses show this tendency. It is thus possible to indicate the position of each Gel on this circle of adjectives. This has been done in figure 8.

The second difficulty encountered pertains to color designation. The best method of color designation is according to dominant wave-length, but there are no wave-lengths corresponding to the purples. These hues must be designated as complements of spectral hues to which definite wave-

lengths may be assigned. It is possible, however, to arrange the hues in a circular scale, by an adaptation of Hardy's charts, so that each color and its complement are on opposite ends of the same diameter and the colors are arranged around the circumference of the circle in the order R, O, Y, G, BG, B, V, VP, P, RP, and R. On such a scale, it is possible to plot the position of each of the Gels used in Set *E*. We now have a circular scale of adjectives and a circular scale of hues. Our next problem is to discover how these two scales are related. To do this we turn our attention to the temperature ratings.

We first arrange the Gels in rank-order, assigning rank 1 to the coldest color, rank 2 to the next colder, and so on to rank 27 for the hottest color. We then refer to the adjective scale shown in figure 8 and find the average rank for all the Gels which cluster about any group of adjectives. When we do this we obtain the ranks shown in Table XXII. Since the average rank of 28 ranks is 14, we may calculate the deviation of each mean rank from 14, deviations which are plus will be hotter than average, and minus deviations

TABLE XXII

RANKS OF TEMPERATURES ASSOCIATED WITH THE GELATINES IN EACH GROUP ON THE ADJECTIVE SCALE

SET E

	Gel No.	Temp. Rank	R_m	$(R_m - 14)$		Gel No.	Temp. Rank	R_m	$(R_m - 14)$
I	60	23			IV	29	1		
	10	25				18	3		
	58	22				41	9		
	W	15				16	5.5		
	6	24				17	4		
	54	17				32	8		
	57	19	21	7		20	12	6	—8
II	2	16			V	—	—	—	—
	9	21							
	8	20	19	5	VI	36	2		
						49	14		
III	75	13				22	18	11	—3
	44	11							
	27	10			VII	—	—	—	—
	48	5.5							
	25	7	9	—5	VIII	11	26		
						61	27	26	12

TABLE XXIII

RANKS OF TEMPERATURES ASSOCIATED WITH GELATINES OF VARIOUS DOMINANT WAVE-LENGTHS

SET E

Wave-Length	Temp. Rank	R_m	R_m —14
650-600	16		
	24		
	27	22	8
600-580	23		
	22		
	19		
	13	19	5
530-510	5.5		
	14		
	17		
	11	12	—2
490-450	10		
	7		
	9		
	1		
	8		
	5.5		
	2	6	—8
579c-575c	3		
	4		
	12		
	18	9	—5
530c-510c	21		
	20		
	26		
	25	23	9

will represent temperatures which are colder than average. It may be seen from the Table that the hotter hues cluster about adjective groups VIII, I and II and the colder ones about III, IV, VI and presumably V.

In a similar manner we deal with the temperature ranks on the circular hue scale and obtain Table XXIII. In the Table the hottest hues are between wave-lengths 530c and 530 on the long wave-length side of the circle and the coldest hues between the same limits on the short wave-length side.

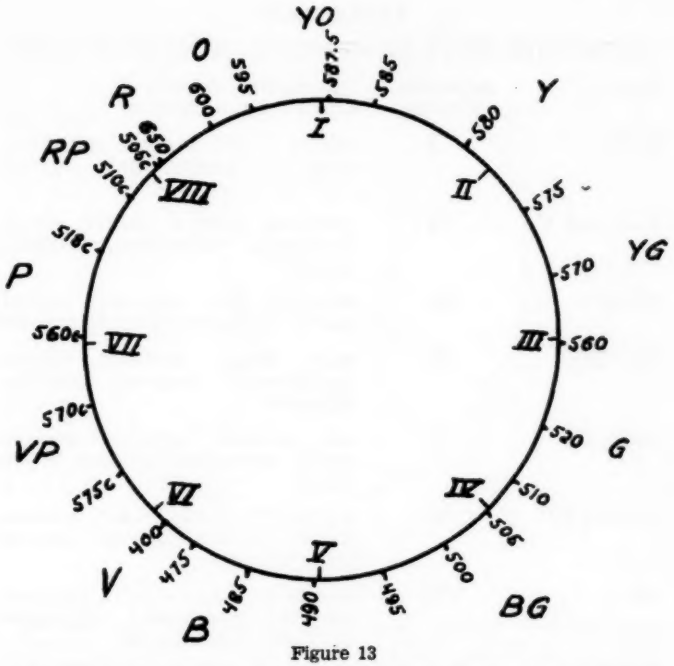


Figure 13

The positions of the various hues on the adjective scale. Roman numerals refer to groups on the adjective list (fig. 12), arabic numerals to wave-length, and letters to color names as given in Table VI.

Now by a comparison of Tables XXII and XXIII we find that the hottest hues are in or near adjective group VIII and also near or between wave-lengths 510c-530c. Also the coldest group of hues are near adjective group IV or V and wave-lengths 450-490.

We can, therefore, superimpose the hue scale on the adjective scale so that the temperature regions agree as highly as possible. The result of this combination is shown in figure 13. From this figure we may generalize as shown in Table XXIV.

It must be remembered that this Table (XXIV) is no arbitrary arrangement, but the result of applying the statistical technique described above. One method of check on its

TABLE XXIV

ADJECTIVES MOST DESCRIPTIVE OF VARIOUS HUES

Hues	Adjective Group	Descriptive Adjectives Chosen by Audience
O-YO	I	bright, vivacious, sprightly, cheerful, happy, gay, joyous, carefree
Y-O and Y	II	sparking, playful, merry, jovial, humorous, whimsical, fanciful, quaint
YG-G	III	delicate, light, graceful, lyrical, poetic, leisurely, gentle, dreamy
(G)-BG	IV	calm, serene, soothing, tender, sentimental, longing, romantic, plaintive
(BG)-B	V	sad, pathetic, mournful, melancholy, depressing, gloomy, heavy, tragic
BV-V-(VP)	VI	dignified, spiritual, solemn, sober, serious, grave, earnest, philosophical
VP-P	VII	dramatic, forceful, vigorous, martial, ponderous, emphatic, majestic, exalting
RP-R-RO	VIII	soaring, triumphant, elated, exciting, impetuous, restless, strong, spirited

validity is to correlate the position of each Gel on the hue scale against its corresponding position on the adjective scale. If the arrangement shown in Table XXIV is valid, the coefficient of correlation of the two positions of the 26 Gels should be 1.0. When the coefficient is calculated, it has a value of 0.82 which indicates a high degree of agreement, in this case sufficient to establish the validity of the arrangement.

A measure of the reliability of the adjective ratings may be obtained by correlating the positions of the Gels on the adjective scale for Set *E* against similar ratings on Set *F* as shown in figures 8 and 11. This coefficient is 0.98, which indicates almost complete agreement between the descrip-

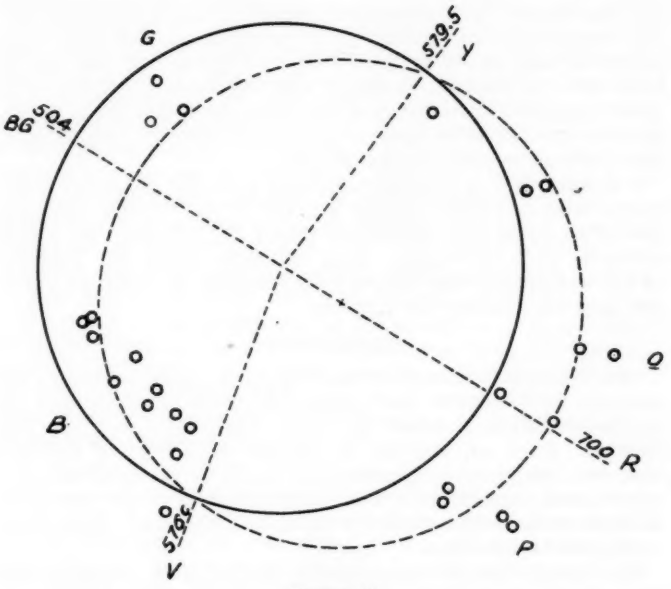


Figure 14

The relation of temperature rating to hue. The solid circle represents a median judgment of "50" measured from the center of the circle. Each dot represents a judged temperature in relation to the center of the circle. The dotted circle is that of best fit to the data, and represents the average judged temperature. Numerals refer to wave-length and letters to color designations as given in Table VI.

tive adjectives used by the subjects in Set *E* and the subjects in Set *F* in describing any hue.

An attempt to determine whether saturation or intensity played any part in determining the adjectives used indicated no relationship between these variables.

Finally, we may investigate the nature of the temperature response which was used to equate the two circular scales. The mean of the temperature ratings for all the Gels is 50.0. In figure 14 the circular scale of hues is used again and degrees of judged temperature are measured from the center of the circle. The temperature of each Gel is thus represented by its distance from the center of the graph and its hue by its position relative to the circumference of the cir-

cle. The heavy circle represents average judged temperature. The dotted circle represents the average of the temperatures. It may easily be seen from the figure that the warm hues are the yellows, oranges, reds (hottest), purples and violet-purples; while the cold hues are the blue-violets, blues, blue-greens (coldest), greens and yellow-greens. Yellow and violet are of neutral temperature.

A comparison of the temperatures with the adjective scale shows that adjective groups III, IV, V and VI are descriptive of cool and cold colors and that I, II, VII and VIII apply to warm and hot colors. This indicates again the validity of the statement that warm colors should be used for comedy and cool colors for tragedy.

CONCLUSION

The studies discussed in the foregoing paper represent an attempt to measure the mood-reactions of audiences to lights of different colors as they might be seen in the theater. Such an attempt is fraught with myriad difficulties, and the results reported here must be accepted as tentative and exploratory. They have proved to be, however, unexpectedly self-consistent and in essential agreement with artistic intuition.

The results are not presented with complete disregard for their limitations, but as indicative of the type of finding which might be expected in more elaborate studies. Amongst the major deficiencies of these investigations, the following may briefly be considered. *First,* questionnaire methods do not allow full expression of individual reactions. But some limitation of individual freedom is necessary else it becomes impossible to analyze the data, as was shown in Sets *A, B* and *C. Second,* the groups were small. This restriction was necessary since the complete analysis, for exploratory purposes, of large groups would have meant wasting time on methods which subsequently proved useless. Moreover, the consistency of responses from group to group indicates that group judgments are fairly reliable even with limited numbers. *Third,* the groups tested were not actual theater audiences. They represent, however, groups which are thoroughly naive in the traditions of the theater and their responses should be indicative of what might be expected of actual audiences. *Fourth,* only single colors on evenly illuminated surfaces were presented and no actual dramatic scenes presented. But scientific investigation must be content with starting at the beginning and proceeding painstakingly. In

scientific research no leap of intuition can replace the necessity for careful progress. Each element must be analyzed by itself first and then in combination with other elements. This is a preliminary study of one of the basic phases of theater lighting. *Fifth,* the results present nothing new to knowledge in and of the theater. It is necessary, however, to distinguish between artistic practice on the one hand and laboratory research on the other; between artistic intuition and scientific demonstration. Too frequently in the history of science false intuition has dominated the scene and was only dislodged with difficulty. On the other hand, should audience reaction confirm artistic intuition, then, indeed, we may have more than intuitional faith in intuition.

It is with a full knowledge of the above, and many other methodological and statistical limitations, that the conclusions are presented. The most important conclusion is that the method is sufficiently fruitful to warrant further study. More specific conclusions are presented as indicating possible lines for further research.

In reacting to colors, individuals tend to name specific times, places or actions if they are not asked specifically for moods. In the theater, time and place are usually stated on the program, and indicated by the set and the lines, while the action proceeds according to the dictates of the play rather than the predispositions of the audience. In actual practice, although having specific "suitability" for time, place and action, color probably contributes more to mood than to the designation of these ideational elements. But an attempt to read behind images to mood reaction is doomed to failure from the start. The mood value of any image depends too largely on the experience of the reacting individual. Even the technique of asking for mood-reactions only gives results too complex for analysis. There are at least 16,000 adjectives in the English language which might be used to indicate mood-responses. Aside from the impossibility of reducing these to a reasonable number from the data, the question of the quantity of each response still remains. If an individual rates "blue" as tragic, gloomy, romantic, serene and pleasant, we are at a loss to know which of these is considered more characteristic of the color. It would seem more economical and meaningful to ask the subject to rate the color on several different descriptive scales by indicating how much of each mood-quality he judges the color to have. The scales used in these studies allow the audience to state the suitability of the various

colors for scenes according to their *emotionality, affectivity* (pleasantness or unpleasantness), *activity, tension, temperature, tragedy, comedy, melodrama* and *romance.* In addition, lists of selected adjectives, descriptive of various moods, were provided so that the individual could check those adjectives which he considered appropriate.

One of the most striking features of the results is their consistency from group to group. Although there has been no retest of the same group on the same colors, the same group indicated what they thought their responses would be by stating their reactions to color names and later rated actual colors. The correlation of the two sets of responses was significantly high (0.76). Also, two different groups rated the same colors, with slightly better correlation (0.80). These two findings indicate that we may expect much the same type of response from any similar groups. It would indicate either that our cultural heritage is such that we all learn the "correct" responses, or that there is some innate mood-reaction to different colors. The subject needs further investigation before any choice between the two alternatives may be made.

A comparison of the groups indicated that individual judgments are much less reliable than group judgments. Since we are interested, however, in audience reactions, no analysis has been made of individual responses other than to indicate their consistency (Table IV). On the other hand, we may generalize from the responses of both groups rather than being forced to limit our conclusions to one group or the other.

The next question which may arise concerns the validity of the tests. Although it is true that groups show consistency of response, what they are responding to may be something different than the label on the scale. There are only two tests for validity. The first concerns the relationship of responses to "comedy" and to "tragedy." These two categories of description are antithetical and we should expect that if the groups were really judging the comic and tragic values of a color, that if they rated the color high on one attribute they would rate it low on the other if the scales are valid. Such is indeed the case, for throughout the sets we discover more consistency in the relationship between these qualities of a color than between any others (*D*, —0.87; *E*, —0.90; *F*, —0.77). We are thus justified in assuming that the ratings are made with an attempt at sincerity of responding to the scale as labeled. We are also persuaded of

the same fact by virtue of the agreement between the experimental results and many of the artistic intuitions which are extant in the theater; that warm colors denote comedy and cool ones tragedy, for example.

The relation of brightness and saturation, as well as hue, to mood response is of particular significance. Colors differ not only in hue, but as well in brightness and saturation, and each of these qualities of the color is important. Irrespective of the hue, the results indicate that high brightnesses are associated with hot, active and comic scenes, whereas low brightnesses are associated with emotional, tense, tragic, melodramatic and romantic scenes. These findings are in essential agreement with practice; the brightly illuminated stage is rarely used for tragic, emotional or romantic playing. High saturation, on the other hand, goes with scenes which are emotional, tense, hot, comic and melodramatic. The lack of definite relationships of mood-reaction to low saturation probably arises from the fact that desaturate colors appear grey, so that a difficulty arises from a confusion of hues.

The "temperature" scale proved to be the most interesting and useful one inasmuch as it provided a means of relating hues to the scales. The audiences were very adept at specifying the temperature of colors, as reference to figure 13 will show. The temperature is related to the brightness and saturation of a color, as Tables XII and XIX show, but a further analysis indicates that hue is by far the most determining factor. The order of temperatures, from figure 13, is approximately as follows: (1) Red; (2) Orange and Purple; (3) Orange-Yellow and Purple-Violet; (4) Yellow and Violet; (5) Blue and Yellow-Green; (6) Blue-Bluegreen and Green and (7) Bluegreen. Keeping in mind the circular nature of the scale, we find that the warm colors are associated with activity and comedy, and the cool colors with tragedy and possibly romance. This finding confirms, of course, the practice of the theater.

A comparison of the interrelationships of the various scales brings to light the following associations: colors which are rated as emotional tend also to be tense, melodramatic, and possibly tragic and romantic. Colors which are rated as active are associated with comedy, hot temperatures and are ill-suited for tragedy. Colors which are rated as tense are associated with emotionality, tragedy and melodrama. The warm colors are comic, the cool ones tragic, and colors suited for tragedy are also suited for melodrama. There are

TABLE XXV

HUE, SATURATION AND BRIGHTNESS OF COLORS WHICH CREATE A HIGH DEGREE OF THE MOOD-QUALITY INDICATED

	Emot.	Aff.	Act.	Ten.	Temp.	Trag.	Com.	Melo.	Rom.
Hue	(Purple)	?	hot	?	——	cold	hot	?	(BG)
Saturation	high	?	?	high	high	(high)	high	high	?
Brightness	low	?	high	low	high	low	high	low	low

Parentheses are used in highly questionable cases.

slight indications that colors suited for romance are pleasant, that comic colors are not melodramatic ones, and that melodramatic colors may be used for romance. These relationships are arbitrarily chosen from the Tables, and only a study of the appropriate Tables and bar-diagrams can give a complete and accurate picture of the findings.

In analyzing the adjective groups, it was impossible to demonstrate any relationship between the adjectives chosen and the brightness or saturation of the color, presumably because the hue dominated the response. Reference to Table XXIV shows, however, the descriptions given to the various hues by the audience. Here again we find that the data confirm theater usage in a large measure.

Although it is highly dangerous and misrepresentative, the findings of this study have been summarized in Table XXV. It should be kept clearly in mind that this Table represents an unwarranted finality concerning the conclusions. It is presented only in the interests of giving tentative generalizations, the validity and reliability of which must be checked by further study. It will be noted that no results are possible for "affectivity" until further analyses have been made.

Finally, we may inquire into the nature of color reactions in general. Two theories present themselves for consideration. According to the first, reactions to colors are innate and in that sense natural. Whether such reactions are occasioned by inherited nervous structure or by the biological transmission from generation to generation of the experience of the race, this theory holds that all persons naturally and automatically respond to a given color with a constitutionally predetermined reaction. Such a theory would imply a high degree of consistency in the reactions of different individuals within the same culture, and individuals of one culture, transplanted in infancy to another society, would show the color reactions indigenous in their cultural

stock rather than develop the reactions characteristic of the environment in which they develop.

According to the second theory, color reactions result from individual experience and learning. Associations of "red" with fire, with the flushed face of excitement or passion, with the afterglow of a sunset or the many other phenomena which occur with considerable regularity in the lives of all individuals, lead to reactions which are consistent inasmuch as the experiences of the individuals are in this regard similar. Color reactions would vary from culture to culture as social traditions vary, and from individual to individual as personal experiences vary.

To choose between these alternative theories is not difficult, but to justify one's choice with scientific rigor is an entirely different matter.

The adequate stimulus for a color reaction is obviously a color stimulus. From the results obtained thus far in these studies we would conclude that the three attributes of color —hue, saturation and brightness—each play a different part in determining the nature of the reaction. But whether the response is natural or acquired is not indicated by the data.

The fact that the reactions of the naive and sophisticated groups are in high agreement would indicate that the difference in training, at least at this level, is not a differentiating factor. On the other hand, the difference in the specificity of response on the adjective scales would imply that the trained group has learned to describe its reactions with greater precision than has the untrained group. It would appear that at this stage of development the trained subjects are not experiencing different reactions but are more apt in describing their experience.

The solution of the problem of the "cause" of color reactions must await the completion of careful investigation and study of the characteristic differences in the color reactions of widely disparate cultures in which dramatic art flourishes.

In the meantime, from the results of these studies, we are only justified in concluding that groups in the particular culture studied tend to react to colors seen in theatrical situations as to an integration of hue, saturation and brightness, and that they react with a significant degree of consistency and predictability.

APPENDIX A

INSTRUCTIONS FOR SET *D*

STUDIES IN THE PSYCHOLOGY OF THE THEATER

The purpose of this study is to discover how people react to colors as they are seen in the theater. At the top of each of the following pages is a color name; for instance, red, blue, green, etc. In each case it is to be assumed that the color is a medium one of moderate intensity; for instance, medium blue or medium red of moderate brightness. On each page, space is provided for rating each color according to nine different scales. The first five of these scales show your personal reaction to the color, and the last four refer to how you think the color is suited to various theatrical situations. In all cases, however, you are asked to rate the color as you would see it in a theatrical situation. Each one of the scales is to be used as follows:

Emotionality. On the scale answer the question, is the color for you a highly emotional one, or a color possessed of only a little emotionality? The middle of the scale is to be taken as moderate emotionality. More specifically, is this color adapted to a highly emotional scene, or one in which the emotional content is low? Put a *check mark* on the scale at the point which in your opinion best characterizes the emotional content of the color.

Affectivity. This is a pleasantness-unpleasantness scale. Do you think that the scene which should be lighted with this color should be very pleasant, very unpleasant, or more or less neutral? Or if a scene were so lighted, would you find it pleasant or unpleasant?

Activity. Should the amount of activity, the amount of movement, present on the stage which is lighted with this color, be very high—that is, much activity—or should the scene have little movement in it?

Tension. On this scale answer the question, is the dramatic situation for which this color should be used, tense or relaxed? The scale should not be confused with that for activity or the one for emotionality.

Temperature. On this scale indicate whether you think

this is a hot color, a cold one, or one of moderate temperature.

Tragedy. Indicate to what extent you think this color is suited to a tragic scene or what degree of tragedy this color may be used for. Remember that a scene may be at the same time tragic and romantic, or comic, or melodramatic.

Comedy. Indicate how well you think this color is adapted to comedy, or how comic a scene the color could be used with.

Melodrama. How well is this color suited to a melodramatic scene, or how melodramatic may a scene lighted with this color be?

Romance. Indicate the suitability of the color for romantic scenes—how romantic may the scene lighted with this color be?

In all cases the middle of the scale is to be taken as the most moderate situation. At the end of each page is a line for comment. If you feel that the scales are inadequate for expressing your reaction to the color as you might see it used in the theater, indicate on this line your comment with regard to the situation.

Use *check marks* so that the point of the mark falls on the scale at the point which you wish to mark. Do not spend too much time on any color. Be sure your name is on this paper!

APPENDIX B

INSTRUCTIONS FOR SETS *E* AND *F*

STUDIES IN THE PSYCHOLOGY OF THE THEATER

Name ..... Age .... Race ..... Sex: M F
Schooling: 1 2 3 4 5 6 7 8 9 10 11 12 College 1 2 3 4 Graduate 1 2 3 4
Occupation ..... Residence (most of your life)
..... (City) (State)
Approximately how many plays have you seen in the legitimate theater during the past year? .....
In how many plays have you acted during the past year?....
In how many have you done technical work (scenery, costumes, etc.)? .....
How many courses in acting or production have you had in school? .....

Are you actively interested in the graphic arts (painting, design, etc.)? ..... If so, how many works have you completed during the past year? .....

Do you play a musical instrument or sing? ..... Do you belong to an orchestra, chorus, or give concerts? ..... How often have you performed during the past year? ..... How many concerts have you attended during the past year? .....

The purpose of this study is to discover how people react to different colors as they are seen in the theater. At the top of each of the following pages is a number which refers to a color which you will see on the screen at the front of the room. Whenever a color is thrown on this screen you will be told its number. Turn to the pages corresponding to this number and fill in the scales. There are two pages for each color. *Always fill in the first page before you turn to the second.* The scales on the first page are to be used as follows:

Emotionality. On this scale indicate whether you think the color is a highly emotional one or one possessed of little emotion. Place a *check mark* ($\surd$) on the scale at the point which in your opinion best characterizes the color.

Affectivity. This is a pleasantness-unpleasantness scale. If a stage were lighted with this color, would you find it pleasant or unpleasant?

Activity. Should the amount of activity or movement on a stage lighted with this color be very high, or should the scene have little movement in it?

Tension. Would the dramatic situation for which this color should be used be tense or relaxed? This scale should not be confused with those for activity or emotionality.

Temperature. On this scale indicate whether you think the color is a hot or cold one, or one of moderate temperature.

Tragedy. If the stage were lighted with this color, would you expect a highly tragic scene or one having little or no tragic content? Remember that a scene may at the same time be tragic and comic or romantic or melodramatic.

Comedy. If the stage were lighted with this color, how comic would you expect the scene to be played upon it to be?

Melodrama. If the stage were lighted in this color how melodramatic would you expect the scene to be?

Romance. If the stage were lighted in this color, how romantic a scene would you expect to be played upon it?

In all cases the middle of the scale is to be taken as the most moderate situation. Use check marks to indicate the point of your choice. If you are not sure, guess.

Scales on the second page should be filled in as follows:

Hue. Mark on this scale the position which you think the color would occupy. The symbols refer to the following colors: Red, Orange, Yellow, Green, Blue-Green, Blue, Violet, Purple and Red. Red is placed at both ends of the scale to allow for completeness. If you think the color is pure Red, place a check mark over the R on the extreme *left* of the scale.

Saturation. On this scale indicate how saturate you think the color is. Do not confuse this scale with the one for intensity. Here we are interested in whether you think the color is a deep one or a light one (corresponding roughly to tint or shade). A color may be deeply saturate and at the same time very bright or very dim in intensity.

Intensity. On this scale indicate how bright or dim you think the color is apart from its hue and saturation.

Check-list. Check all the terms in the list which seem appropriate to the color. Notice that the words are grouped together in loosely related classes. Put down your first impression; work rapidly.

Fill in all the scales for each color. If one person omits one scale, the work of evaluating these results is greatly complicated. Please use check marks ($\surd$) and work rapidly.

APPENDIX C

TRI-CHROMATIC COEFFICIENTS FOR BRIGHAM GELATINES

Gel	x	y
Light Flesh Pink #2	.475	.394
Rose Pink #6	.584	.341
Deep Pink #8	.501	.346
Dubarry Pink #9	.501	.340
Light Magenta #10	.553	.301
Medium Magenta #11	.567	.292
Rose Purple #14	.458	.226
Violet #16	.271	.223
Special Lavender #17	.407	.332
Medium Lavender #18	.350	.256

Light Purple #20	.343	.204
Royal Purple #22	.335	.136
Daylite Blue #25	.332	.371
Light Sky Blue #26	.371	.366
Light Blue #27	.220	.340
Special Steel Blue #29	.303	.323
Medium Blue #32 (special)	.177	.230
Non-Fade Blue #36	.159	.106
Moonlight Blue #41	.230	.328
Medium Blue-Green #44	.152	.475
Medium Green #48	.287	.610
Dark Green #49	.231	.679
Light Straw #54	.479	.426
Light Amber #57	.542	.439
Medium Amber #58	.571	.409
Dark Amber #60	.599	.388
Orange #61	.634	.364
Light Scarlet #62	.499	.409
Fire Red #67	.657	.337
Grey #75	.461	.421

These coefficients were determined by Dr. Sidney Newhall at The Johns Hopkins University.